

## **TECHNICAL FISHERY REPORT 90-16**

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Alaska Department of Fish and Game  
Division of Commercial Fisheries  
P.O. Box 3-2000  
Juneau, Alaska

October 1990

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### **Bristol Bay Sockeye Smolt Studies for 1988**

by

**James D. Woolington, Beverly A. Cross  
Barry L. Stratton, and Brian G. Bue**

The Technical Fishery Report Series was established in 1987, replacing the Technical Data Report Series. The scope of this new series has been broadened to include reports that may contain data analysis, although data oriented reports lacking substantial analysis will continue to be included. The new series maintains an emphasis on timely reporting of recently gathered information, and this may sometimes require use of data subject to minor future adjustments. Reports published in this series are generally interim, annual, or iterative rather than final reports summarizing a completed study or project. They are technically oriented and intended for use primarily by fishery professionals and technically oriented fishing industry representatives. Publications in this series have received several editorial reviews and at least one *blind* peer review refereed by the division's editor and have been determined to be consistent with the division's publication policies and standards.

BRISTOL BAY SOCKEYE SALMON SMOLT STUDIES FOR 1988

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Barry L. Stratton, and Brian G. Bue

Technical Fishery Report No. 90-16

Alaska Department of Fish and Game  
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November 1990

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## ACKNOWLEDGEMENTS

Many people contributed towards the collection of smolt data and supervision of the projects. The following seasonal employees of the Alaska Department of Fish and Game, Division of Commercial Fisheries, collected smolt data during the 1988 field season at the various smolt sites: Dan Salmon, Roger Dunbar, Don Perrin, Susan McNeil, Robert Zanella, Kenneth Legg, Len Osimowicz, Fred Tilly, Roxanne Peterson, Richard Feia, Bill Bale, Dan Roberts, Michael Domier, Debbie Brocke, Dulce Ben, Mike East, and Jim Menard. Chuck Meacham, Steve Fried, Don Bill, Jeff Skrade, and Wes Bucher provided supervisory support and editorial comments.

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## ABSTRACT

Numbers of sockeye salmon (*Oncorhynchus nerka*) smolt migrating to sea from six rivers in Bristol Bay, Alaska, in 1988 were estimated from sonar counts and age-weight-length samples. Hydroacoustic equipment was used to estimate total smolt biomass, while age-weight-length samples were used to convert biomass estimates to numbers of smolt by age group. Numbers of smolt migrating from each river were 100,173,692 from Kvichak River; 48,961,215 from Egegik River; 215,968,015 from Ugashik River; 40,799,537 from Wood River; 8,593,550 from Nuyakuk River; and 2,607,013 from the Togiak River. Most smolt migrating from the Kvichak River (86.9%) were age II, (the progeny of 1985 spawners). Most smolt migrating from the Egegik (73.8%), Ugashik (84.6%), Wood (97.6%), Nuyakuk, (96.7%) and Togiak (99.4%) Rivers were age I (the progeny of 1986 spawners).

KEY WORDS: smolt, sockeye salmon, *Oncorhynchus nerka*, smolt migration, sonar, Bristol Bay, Kvichak River, Egegik River, Ugashik River, Wood River, Nuyakuk River, Togiak River

## INTRODUCTION

The Bristol Bay Management Area includes all waters east of a line from Cape Newenham to Cape Menshikof (Figure 1) and supports the largest sockeye salmon (*Oncorhynchus nerka*) fishery in the world. The average commercial catch from 1978 through 1987 in Bristol Bay averaged 21.3 million sockeye salmon. To effectively manage this valuable fishery, managers need accurate abundance forecasts for returning adults and information on optimal spawning escapement goals. Estimates of smolt numbers are used as an index of production from adult salmon, which in turn should improve the accuracy of preseason forecasts and aid in setting goals for optimal numbers of spawners.

Fyke nets were used to estimate smolt numbers on the Kvichak River from 1956 through 1970, on the Naknek River from 1956 through 1978, on the Egegik River during 1957, 1969, and 1978, on the Ugashik River from 1955 through 1965, 1967 through 1970, and 1972 through 1975, and on the Wood River from 1955 through 1966 (see Kerns 1961; Rietze and Spangler 1958; Jaenicke 1968; Pella and Jaenicke 1978; Burgner and Koo 1954; Burgner 1962). Fyke net sampling provided information on age, size, and relative abundance of smolt but did not accurately estimate total numbers of smolt. To improve estimates of smolt numbers, hydroacoustic equipment developed by Bendix Corporation was tested on the Kvichak River in 1969 (McCurdy and Paulus 1972; Paulus and Parker 1974). Further testing and modifications of this prototype resulted in construction of smolt counters for use on the Wood (Krasnowski 1976) and Kvichak Rivers (Randall 1977) in 1975 and 1976.

Hydroacoustic equipment for counting smolt was tested on the Ugashik River from 1973 through 1975 (Schroeder 1974b and 1975; Sanders 1976). Smolt studies on the Naknek, Egegik, Ugashik, and Nuyakuk Rivers were limited to occasional fyke net sampling to obtain age and size data from 1975 through 1982 (Huttunen 1980; Eggers 1984; Minard 1984). An experimental, two-array sonar system, similar to the one used on the Kvichak River, was tested on the Egegik River during 1981 (Bue 1982).

Smolt enumeration projects using modified counters were started on the Naknek and Egegik Rivers in 1982 (Huttunen 1984; Bue 1984) and the Ugashik and Nuyakuk Rivers in 1983 (Fried et al. 1987; Minard and Frederickson 1987). The migration of smolt from the Naknek River has not been monitored since 1986. A joint State-Federal pilot project using hydroacoustic equipment to enumerate smolt was conducted on the Togiak River in 1988.

Studies were conducted on the Kvichak, Egegik, Ugashik, Wood, Nuyakuk, and Togiak Rivers in 1988 to (1) estimate numbers of seaward migrating sockeye salmon smolt, (2) describe smolt migration patterns, (3) collect age, weight, and length data for smolt, and (4) record climatological and hydrological parameters which may affect migratory behavior.

## METHODS

### *Hydroacoustic Equipment*

Bendix Corporation<sup>1</sup> constructed all hydroacoustic systems used to estimate smolt numbers in Bristol Bay river systems. Transducers were housed in 3.03-m long arrays, which were set on the river bottom and connected by coaxial cable to a control unit located on shore. Transducer arrays used on the Egegik, Ugashik, Wood, Nuyakuk, and Togiak Rivers housed 10 upward-facing transducers. Arrays used on the Kvichak River held seven upward-facing transducers and seven downstream-facing transducers. Arrays were placed in similar locations to previous years and were retrieved at the end of each season.

Hydroacoustic systems were factory calibrated to record one count for a specified amount of fish biomass (Kvichak River, 83.0 g; all other projects 41.5 g) passing through each transducer beam during a given time period. Individual arrays were ranged independently, which allowed the operator to set the counting range as near the surface as possible. Each control unit had a disable switch so the person monitoring the equipment could manually stop tabulation of known false counts (i.e., counts due to floating debris, ice, entrained air from high winds or rain, etc.). The control unit automatically recorded and stored the length of time the system is disabled. The control unit had manual settings for adjusting printing intervals for accumulated counts, transducer pulse rate, and the portion of the water column monitored. Transducer signals characteristics were visually monitored by connecting an oscilloscope to the counting unit. All smolt counters, except for the Wood and Togiak River counters, monitored three transducer arrays. The Wood and Togiak River units monitored two arrays. An additional switching box was added to the Wood River system for manual multiplexing of four arrays.

### *Project Locations*

The counting site on the Kvichak River was located 5 km below the outlet of Lake Iliamna (Figure 1). Three transducer arrays, referred to as *inshore*, *center*, and *offshore*, were anchored 22 m, 42 m, and 61 m from the east bank. The counting site on the Egegik River was located 4 km below the outlet of Becharof Lake. The inshore, center, and offshore arrays were anchored 51 m, 66 m, and 78 m from the south bank. The counting site on the Ugashik River was located 50 m below the outlet of Lower Ugashik Lake. Because of the narrow width of the channel, only two arrays have been used. Movement of the array anchors made it necessary to reposition the arrays three times during the season. The inshore and offshore arrays were anchored 27 m and 35 m from the north bank from May 17 to May 20; 30.5 m and 35 m from May 20 to May 22; and 27 m and 35 m from May 22 through June 13. The counting site on the Wood River was located 1 km below the outlet of Lake Aleknagik. Arrays I, II, III, and IV were anchored 19 m, 34 m, 48.5 m, and 67 m from the north bank. The counting site on the Nuyakuk River

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<sup>1</sup>Mention of Bendix Corporation does not represent an endorsement of any kind.

was located 3.5 km below the outlet of Tikchik Lake. The inshore, center and offshore arrays were anchored 28 m, 50 m, and 74 m from the south bank. The counting site on the Togiak River was located 1 km below the outlet of Togiak Lake. The inshore and offshore arrays were anchored 15 m and 45.5 m from the west bank.

### *Estimation of Smolt Numbers*

The process of estimating smolt numbers was divided into three major steps: (1) determining total fish biomass migrating past the study site; (2) sampling the migrating fish population to estimate species, age, weight, and length composition; and (3) converting fish biomass into numbers of smolt by age and species.

#### Biomass Estimation

Fish biomass was estimated with continually monitored hydroacoustic equipment. Most of the smolt migrate in the upper portion of the water column. The counting range was set to record counts only up to within 1 to 2 cm of the water surface to avoid counting debris or air entrapped on the surface. Sources of false counts such as boats, wind, rain, debris, etc. were noted and the hydroacoustic equipment disabled whenever false counts or false count conditions were detected. Known false counts were subtracted from hourly totals and linear interpolations were used to estimate counts missed while the equipment was disabled.

Signal pulse rate of the smolt counter was set to correspond with the river velocity measured over one array (referred to as the velocity index array). Because velocities of Egegik and Wood Rivers are influenced by tides, a Marsh-McBirney current meter was anchored directly behind the velocity index array to continuously monitor river velocities. The smolt counters at Egegik and Wood Rivers were adjusted every 15 to 30 min to account for changes in river velocity. A Marsh-McBirney meter was also used to monitor river velocities over the Nuyakuk River index array, and the signal pulse rate of the counter was adjusted daily at 1200 hours. Velocities of Kvichak and Ugashik Rivers are more stable than the other rivers, thus river velocities at these sites were measured periodically with a Gurley current meter and the counters adjusted accordingly. To account for differences in river velocities between the index array and the remaining arrays, current readings over each array were taken at specified intervals and velocity correction factors were then calculated as follows:

$$vcf_i = \frac{v_i}{v_{index}} \quad , \quad (1)$$

where:

$vcf_i$  = velocity correction factor for array  $i$ ; and

$v_i$  = velocity over array  $i$ ; and



$V_{\text{index}}$  = velocity over the velocity index array.

Using these correction factors, adjustments for differences in river velocity were made to daily counts for each array as follows:

$$ac_{i,z} = c_{i,z} \text{vcf}_i, \quad (2)$$

where:

$ac_{i,z}$  = adjusted counts for array i on day z; and

$c_{i,z}$  = counts for array i on day z.

All sonar arrays, except those at Wood River, were used to monitor fish biomass 24 hours per day, so daily counts for each array represented actual sonar counts. The counter at Wood River was designed to simultaneously control only two of the four arrays used. Array I (referred to as the index array) was continuously monitored by the unit. The other three arrays were each monitored for 15-min periods each hour. Consequently, total daily counts for array I were known, while those for arrays II, III, and IV were estimated from the 15 min/h counting period:

$$\hat{hc}_{i,z,k} = \sum_{l=1}^p (pc_{i,z,k,l} \frac{4}{p}) , \text{ and} \quad (3)$$

$$\hat{c}_{i,z} = \sum_{k=1}^{24} \hat{hc}_{i,z,k} , \quad (4)$$

where:

$\hat{c}_{i,z,k}$  = estimated counts for array i, day z, and hour k;

$pc_{i,z,k,l}$  = sonar counts for array i, day z, hour k, and counting period l;  
and

$p$  = the number of 15-min periods that array i was monitored during hour k and day z.

If an array was not monitored during an hour, counts were linearly interpolated using estimated counts from the previous and following hours. Estimated  $c_{i,z}$  for Wood River was used in equation (2).

The width of river monitored by each array depended on array length (3.03 m), water depth over the array, and transducer signal beam width as follows:

$$l_{i,z} = 3.03 + 2 \left( d_{i,z} \tan \frac{bw}{2} \right) , \quad (5)$$

where:

$l_{i,z}$  = width of river monitored by array i on day z;

$d_{i,z}$  = water depth over array i on day z; and

bw = transducer beam width, in degrees (18° for Kvichak and Togiak transducers; 9° for transducers at all other rivers).

Arrays were placed perpendicular to the river current, at locations similar to those in previous years. Distances from each array to a reference point on one of the river banks were measured with a marked length of line. Estimates of the inshore and offshore limits of smolt passage were from side-scanning sonar data collected in previous years. At sites where three arrays were used, distances between the following locations were calculated: (1) inshore limit of smolt passage to first array ( $D_1$ ); (2) first to second array ( $D_2$ ); (3) second to third array ( $D_3$ ); (4) third array to offshore limit of smolt passage ( $D_4$ ).

The biomass of fish passing the counting site was estimated as follows:

$$\hat{B}_z = \frac{1}{2} D_1 \left( \frac{ac_{1,z}}{l_{1,z}} \right) + \sum_{i=1}^{na-1} \frac{1}{2} D_i \left( \frac{ac_{i,z}}{l_{i,z}} + \frac{ac_{i+1,z}}{l_{i+1,z}} \right) + \frac{1}{2} D_{na+1} \left( \frac{ac_{na,z}}{l_{na,z}} \right), \quad (6)$$

where:

$\hat{B}_z$  = estimated biomass on day z;

$D_i$  = the distance for interval i; and

na = number of transducer arrays used.

### Age, Weight, Length Estimation

Data on age, weight, and length were obtained from samples of smolt captured in fyke nets. Smolt weight (g) and length (mm from tip-of-snout to fork-of-tail) were measured, while age was determined from scales mounted on glass slides which were read using a microfiche reader. Smolt were designated as age I, II, or III depending on the number of freshwater annuli.

Sample size goals for the Kvichak, Egegik, and Ugashik Rivers were 400 smolt per day. Based on binomial proportions, 400 smolt per day were needed to estimate the daily percentage of each age group within 5 percentage points 95% of the time (Goodman 1965; Cochran 1977). Whenever the daily goal of 400 smolt was not obtained, smolt from subsequent days were combined until a total of at least 400 was reached. Mean length, which is strongly correlated with age, has been shown to differ among fyke net samples from the same day (Minard and Brandt 1986).

Attempts were made to obtain 100 smolt from six different fyke net catches each day to ensure that age composition estimates were representative of the population migrating past the sonar site. Weight and age of smolt are strongly correlated to length. To reduce the time and cost of data collection all smolt collected each day were measured for length (up to a maximum of 600), while only 100 of those smolt were weighed and aged.

Age-I smolt are preponderant each year in the migration from the Wood and Nuyakuk Rivers; consequently, sample goals were lower. Three samples of 100 smolt were collected from the Nuyakuk River each day (300 smolt per day). That level of sampling provided an estimate of the true age proportions within 5 percentage points in excess of 95% of the time (Cochran 1977). As with the Kvichak, Egegik, and Ugashik systems, all smolt collected were measured for length, while only 100 of those were weighed and aged.

Smolt migration patterns for the Wood River made it difficult to consistently collect quantities of smolt; therefore, only 120 smolt were collected each day. Smolt from subsequent days were pooled into a sample of 200. This level of sampling provided an estimate of the true age proportions within 5 percentage points 95% of the time. All 120 smolt were sampled for length, weight, and age.

Weight for smolt measured only for length based on paired weight-length data obtained from smolt sampled for age, weight, and length (Ricker 1975) was estimated by:

$$W_j = a L_j^b, \quad (7)$$

where:

$W_j$  = weight of an age  $j$  smolt; and

$L_j$  = fork length of an age  $j$  smolt.

Age was estimated for smolt measured only for length utilizing an age-length key. (Bue and Eggers 1989). The age-length key used length to categorize age-I or -II sockeye salmon smolt by determining a critical length which minimized classification error. This critical length was chosen such that the number of age-I smolt classified as age-II smolt was equal to the number of age-II smolt classified as age-I smolt.

Due to the variability of age and size composition estimates among subsamples (fyke net catches) taken the same day, daily mean weight and age proportions as the mean of subsampled values were estimated by:

$$\hat{W} = \frac{\sum_{k=1}^m \frac{\sum W_k}{n_k}}{m}, \quad (8)$$

where:

$\hat{W}$  = estimated mean weight of smolt during a sample period;

$m$  = number of subsamples collected during a sampling period;

$w_k$  = observed weights from subsample  $k$ ; and

$n_k$  = number of observations in subsample  $k$ ; and

$$\hat{p}_j = \frac{\sum_{k=1}^m \left( \frac{n_{j,k}}{n_k} \right)}{m}, \quad (9)$$

where:

$\hat{p}_j$  = estimated proportion of age  $j$  during a sample period; and

$n_{j,k}$  = number of observations of age  $j$  in subsample  $k$ .

#### Estimation of Smolt Numbers

Numbers of smolt by age were estimated by combining biomass estimates with estimates of age and weight composition. Mean weight of smolt was used to convert estimates of biomass per count into estimates of smolt per count by

$$\hat{S}PC = \frac{BPC}{\hat{W}}, \quad (10)$$

where:

$\hat{S}PC$  = estimated number of smolt per sonar count; and

$BPC$  = biomass per count.

The estimated number of smolt for each day was the product of smolt per count and estimated biomass, or

$$\hat{N}_z = \hat{B}_z \hat{S}PC, \quad (11)$$

where:

$\hat{N}_z$  = estimated number of smolt in population on day  $z$ .

The estimated number of smolt for each day were then apportioned into age classes as follows:

$$\hat{N}_{j,z} = \hat{N}_z \hat{p}_j, \quad (12)$$

where:

$\hat{N}_{j,z}$  = estimated number of smolt of age  $j$  on day  $z$ .

Finally, daily estimates of smolt numbers were summed to provide season totals of smolt passing the site:

$$\hat{N}_{\text{tot}} = \sum \hat{N}_z, \text{ and} \quad (13)$$

$$\hat{N}_{j,\text{tot}} = \sum \hat{N}_{j,z}, \quad (14)$$

where:

$\hat{N}_{\text{tot}}$  = estimated total number of smolt which passed site during season;  
and

$\hat{N}_{j,\text{tot}}$  = estimated number of smolt of age  $j$  which passed the sonar site during the season.

### *Climatological Data Collection*

Climatological data was recorded at each counting site. Observations on sky conditions, wind direction, wind velocity (km/h), daily precipitation (mm), air temperature (°C), and water temperature (°C), were recorded at 0800 and 2000 hours daily.

## RESULTS

### *Kvichak River*

A total of 1,951,104 sonar counts were recorded at the Kvichak River counting site from May 22 through June 16, 1988 (Table 1). Most counts were recorded over the offshore array (50.0%). Few counts were recorded over the inshore array (9.3%). Daily sonar counts were greatest from May 28 through June 2, during which 48.3% of the counts were recorded. Side scanning sonar information collected during previous years at the counting site (Cross et al. 1990) indicated that most smolt migrated within a 68 m corridor which began 6.4 m from the east bank. River velocity measurements over the offshore (index) array ranged from 1.6 m/s to 1.8 m/s and were used to adjust the sonar counter firing rate. Velocity correction factors for the three arrays were as follows:

	Inshore	Center	Offshore
May 22 - May 29	0.96	1.00	1.00
May 30 - June 7	0.97	1.00	1.00
June 8 - June 16	0.98	1.00	1.00

An estimated 100,173,692 sockeye salmon smolt migrated from the Kvichak River in 1988 based on sonar counts (Table 2). Age-II smolt (1985 brood year) comprised 86.9% of the total migration (Table 2). The daily percentage of age-II smolt decreased throughout the duration of the migration. The mean weight of smolt generally decreased throughout the season, and consequently the estimated number of smolt per count increased (Table 3). Total smolt production from the 1985 spawning escapement of 7,211,046 sockeye salmon was 13.6 smolt per spawner (Table 4). Average marine survival has been 11.2% for age-I smolt (1969-1984 brood years) and 12.9% for age-II smolt (1968-1983 brood years; Table 5).

Age, weight, and length data were collected from 2,243 sockeye salmon smolt in 1988 (Table 6). Mean weights of age-I, -II and -III smolt in 1988 were 5.6 g, 8.3 g, and 9.8 g. Mean lengths of age-I, -II, and -III smolt in 1988 were 86 mm, 99 mm, and 107 mm. Age-I and -II smolt from the Kvichak River in 1988 were smaller (NSC = nonstatistical comparison) in length and weight than the 1955-1987 average (Table 7). An additional 12,129 smolt were measured only for length (Table 8). Mean smolt weight increased (NSC) after June 10; therefore different discriminant lengths were used before and after June 10 to determine proportions of age groups.

River and weather conditions were recorded at the counting site from May 17 through June 17 (Table 9). Operation of the project was not greatly affected by weather conditions in 1988. Mean water temperature during the project was 7.1° C (range 3.0-9.1 °C), which was warmer (NSC) than the 1963-1987 mean of 5.5 °C (Table 10). Mean water temperature during the peak of the smolt migration on June 1 and 2 was 6.3 and 6.8 °C.

### *Egegik River*

A total of 3,362,865 sonar counts were recorded at the Egegik River counting site from May 18 through June 13, 1988 (Table 11). Most counts occurred over the center array (44.3%). Daily sonar counts were greatest from May 23-28 when 67.6% of the counts were recorded. Side-scanning sonar information collected at the counting site during previous years (Cross et al. 1990) indicated that most smolt migrated past in a 71-m corridor which began 12.2 m from the west bank. River velocity at the counting site ranged from 0.66 to 0.98 m/s over the sonar arrays. Velocity correction factors for the inshore, center, and offshore arrays were as follows:

	Inshore	Center	Offshore
May 18 - May 20	0.83	1.00	0.90
May 21 - May 24	1.00	1.21	1.11
May 25 - May 31	1.00	1.19	1.22
June 1 - June 9	1.00	1.00	1.04
June 10 - June 13	1.00	1.14	1.13

An estimated 48,961,215 sockeye salmon smolt migrated from the Egegik River in 1988 based on sonar counts (Table 12). Age-I smolt comprised 73.8% of the total migration. The daily percentage of age-II smolt decreased throughout the duration

of the migration. The mean weight of smolt decreased throughout the season, consequently the estimated number of smolt per count increased. Total smolt production from the 1985 spawning escapement of 1,095,204 sockeye salmon was 15.70 smolt per spawner (Table 14). This was the lowest production from a single brood year recorded from this project. Average marine survival has been 22.1% for age-I smolt (1980-1984 brood years) and 26.2% for age-II smolt (1979-1983 brood years; Table 15).

Age, weight, and length data were collected from 1,595 sockeye salmon smolt in 1988 (Table 16). Mean weights of age-I, -II, and -III smolt were 10.2 g, 14.3 g, and 21.2 g. Mean lengths of age-I, -II, and -III smolt were 103 mm, 117 mm, and 136 mm. Age-I smolt were about equal in size to the historical average, while age-II were smaller (NSC), and age-III were larger (NSC) (Table 17). An additional 6,530 smolt were measured for only length (Table 18). Mean smolt weight increased (NSC) after June 8; therefore different discriminant lengths were used before and after June 8 to determine proportions of age groups.

River and weather conditions were recorded at the counting site from May 19 through June 14 (Table 19). Becharof Lake was virtually free of ice when smolt operations began, so drifting ice from the lake did not pose any problems with counting in 1988. Mean water temperature during the season was 6.4 °C (range 3.0-10.1 °C), which was slightly higher (NSC) than the 1981-87 average of 6.1 °C (Table 20).

#### *Ugashik River*

A total of 15,349,665 sonar counts were recorded at the Ugashik River sonar counting site from May 17 through June 13, 1988 (Table 21). Most counts were recorded over the offshore array (87.1%). Daily sonar counts were greatest on June 6, 7, and 11, when 48.4% of the counts were recorded. Side-scanning sonar information collected during previous years at the counting site (Cross et al. 1990) indicated that most smolt migrated past in a 21-m corridor which began 7 m from the north bank. River velocities over the inshore and offshore arrays measured on May 17 were 2.1 and 2.2 m/s and remained relatively constant throughout the season. The sonar counter was set at the velocity initially measured over the offshore array (2.2 m/s). Velocity correction factors used for the entire season were 0.95 and 1.00 for the inshore and offshore arrays.

An estimated 215,968,015 sockeye salmon smolt migrated from the Ugashik River in 1988 based on sonar counts (Table 22). Age-I smolt (1986 brood year) comprised 84.6% of the total migration. Although age-I smolt predominated throughout the entire counting period, the percentage of age-II smolt generally decreased throughout the season. The estimated number of smolt per sonar count ranged from 4.7 to 7.2 (Table 23). Total smolt production from the 1985 spawning escapement of 998,232 sockeye salmon was 38.77 smolt per spawner (Table 24). This was less than the production calculated for the 1981, 1982, and 1984 brood years, but greater than the production calculated for the 1983 brood year. Average marine survival has been 6.3% for age-I smolt (1981-1984 brood years) and 12.3 for age-II smolt (1980-1983 brood years; Table 25).

Age, weight, and length data were collected from 2,581 sockeye salmon smolt in 1988 (Table 26). Mean weights of age-I and -II smolt were 5.7 g and 10.8 g. Mean lengths for age-I and -II smolt were 87 mm and 109 mm. Age-I and -II smolt were smaller (NSC) than the 1958-1987 average. (Table 27). An additional 15,451 smolt were sampled only for length (Table 28).

River and weather conditions were recorded at the counting site from May 15 through June 15 (Table 29). Average water temperature was 6.6 °C (range 3.5-10.0°C), which was slightly warmer (NSC) than the 1983-1987 average of 5.9°C (Table 30).

### *Wood River*

A total of 1,090,814 sonar counts were recorded at the Wood River counting site from June 4 through August 1 (Table 31). The greatest count for a single day occurred on June 4, indicating that the smolt migration had begun prior to deployment of the sonar equipment. Consequently, the total number of sonar counts and resulting estimate of smolt migration should be considered a minimum. The distribution of counts over the four arrays was 18.0% over array I, 35.1% over array II, 26.5% over array III, and 20.5% over array IV. This pattern was similar to that observed in past years (Table 32). Side-scanning sonar data was not collected in 1988 to describe lateral smolt distribution. Lateral distribution was assumed to be a function of river width and depth, which were measured and recorded during times when tidal influence was minimal. Based on those measurements, smolt were assumed to migrate within a 94-m corridor which began 3.3 m from the north bank. River velocity at the counting site ranged from 1.20 m/s to 2.09 m/s over the inshore (index) array. Velocity correction factors used for the remaining three arrays were calculated 10 times during the season (Table 33).

An estimated 40,799,537 sockeye salmon smolt migrated from the Wood River in 1988 based on sonar counts (Table 34). Age-I smolt (1986 brood year) comprised 97.6% of the total. Mean weight of the age-I smolt generally increased throughout the season, and the estimated number of smolt per sonar count decreased (Table 35).

Total smolt production from the 1985 spawning escapement of 939,000 sockeye salmon was 31.96 smolt per spawner (Table 36). Production from the 1973-1984 brood years has ranged from a low of 12.29 smolt per spawner (1980 brood year) to a high of 111.83 smolt per spawner (1977 brood year). Average marine survival has been 6.8% for age-I smolt (1973-84 brood years), and 6.9% for age-II smolt (1972-1983 brood years; Table 37).

Age, weight, and length data were collected from 4,540 sockeye salmon smolt in 1988 (Table 38). Mean weights of age-I and -II smolt were 6.3 g and 9.2 g. Mean lengths of age-I and -II smolt were 87 mm and 100 mm. Mean length and weight of smolt in 1988 were similar to the 1951-87 average (Table 39). Infection by



*Triacanthoporus crassus* occurred in 40.8% of 4,449 age-I smolt that were examined and in 46.4% of 110 age-II smolt (Table 40). The incidence of *T. crassus* has generally increased (NSC) since 1978 (Table 41).

River and weather conditions were recorded at the counting site from June 3 through August 1 (Tables 42 and 43). Mean water temperature during the season was 8.8 °C (range 3.5-15.5 °C), which was similar (NSC) to the 1975-87 average of 8.1 °C (Table 44).

### *Nuyakuk River*

A total of 146,462 sonar counts were recorded at the Nuyakuk River counting site from May 28 through July 1, 1988 (Table 45). Counts were distributed similarly over the center (39.7%) and offshore arrays (38.0%). Daily sonar counts were greatest on May 7, 11, and 12, during which 51.4% of the counts were recorded. Side-scanning sonar information collected during previous years (Cross et al. 1990) indicated that most smolt migrated within an 81-m corridor which began 12.3 m from the south bank. River velocity over the inshore (index) array was determined daily at 1200 hours and ranged from 0.79 to 1.34 m/s. River velocity was measured every 5 days over the center and offshore arrays to determine velocity correction factors (Table 46).

An estimated 8,593,550 sockeye salmon smolt migrated from the Nuyakuk River in 1988 based on sonar counts (Table 47). Age-I smolt (1986 brood year) comprised 96.7% of the 1988 total migration. The mean weight of smolt increased slightly throughout the counting period: consequently the number of smolt per count decreased from 12.2 on May 27 to 10.9 on June 26 (Table 48).

Total smolt production from the 1985 spawning escapement of 429,162 sockeye salmon was 17.63 smolt per spawner, which was on the low side of the range of 13.13 to 71.46 smolt per spawner observed for the 1981-85 brood years (Table 49). Average marine survival has been 5.1% for age-I smolt (1981-1984 brood years) and 12.4% for age-II smolt (1980-1983 brood years; Table 50).

Age, weight, and length data was collected from 2,612 sockeye salmon smolt in 1988 (Table 51). Mean weights of age-I and -II smolt were 3.6 g and 5.1 g. Mean lengths age-I and -II smolt were 75 mm and 85 mm. Age-I and -II smolt in 1988 were smaller (NSC) in length and weight than the 1978-87 average (Table 52). An additional 5,017 smolt were measured for length (Table 53).

River and weather conditions were recorded at the Nuyakuk counting site from May 25 through June 27 (Table 54). Nuyakuk Lake was covered with ice when the sonar project began, and ice and debris drifting downstream was commonly observed through early to mid-June. Mean air and water temperatures during the project were 10.5 °C (range 4.5-19.5 °C) and 5.2 °C (range 2.0-10.0 °C).

### *Togiak River*

A total of 29,332 sonar counts were recorded at the Togiak River counting site from June 6 to June 30 (Table 55). Most counts were recorded over the offshore array (71.0%). Side-scanning sonar information to determine the inshore and offshore limits of smolt passage was not available. Based upon the water depth along each shore, it was assumed that smolt migrated downstream across the entire width of the river. River velocity at the counting site ranged from 1.4 m/s to 2.1 m/s. Velocity correction factors for the inshore and offshore arrays were determined each day (Table 56).

An estimated 2,606,013 sockeye salmon smolt migrated from the Togiak River in 1988 based on sonar counts (Table 57). Smolt were observed passing down river several days prior to deployment of the sonar arrays on June 6 (W.A. Bucher, Alaska Department of Fish and Game, Dillingham, personal communication). This estimate of smolt numbers should be considered a minimum. Age-I smolt (1986 brood year) smolt comprised 99.4% of the total migration. The estimated numbers of age-II smolt (1985 brood year) remained low throughout the season, though the greater portion of these occurred midseason. Mean weight of smolt decreased slightly throughout the counting period, consequently the numbers of smolt per count increased slightly (Table 58).

Age, weight, and length data were collected from 1,803 sockeye salmon smolt (Table 59). Mean weights of age-I and -II smolt were 3.9 g and 7.4 g. Mean lengths of age-I and -II smolt were 73 mm and 91 mm.

River and weather conditions were recorded at the counting site from June 3 through June 29 (Table 60). Mean air and water temperatures were 12.8 °C (range 4.5-22.0 °C) and 4.5 °C (range 3.3-5.5 °C).

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Table 1. Sonar counts recorded from three arrays each with 14 transducers at the sockeye salmon smolt counting site on the Kvichak River, 1988.

Sonar Counts				
Transducer Array				
Date <sup>a</sup>	Inshore	Center	Offshore	Total
5 22	5,552	13,365	4,852	23,769
5 23	21,776	56,034	86,683	164,493
5 24	15,332	39,356	57,265	111,953
5 25	6,674	33,458	21,737	61,869
5 26	4,206	14,339	9,787	28,332
5 27 <sup>b</sup>	5,732	25,587	14,973	46,292
5 28	14,513	68,427	47,880	130,820
5 29	8,337	40,736	60,808	109,881
5 30	9,266	27,075	93,088	129,429
5 31	5,331	20,967	45,526	71,824
6 01	27,519	102,096	160,942	290,557
6 02	7,314	81,869	121,485	210,668
6 03	3,558	15,295	25,659	44,512
6 04	1,753	8,611	10,160	20,524
6 05	3,456	14,030	14,979	32,465
6 06	538	6,828	3,826	11,192
6 07	2,540	13,634	19,600	35,774
6 08	3,863	19,122	13,811	36,796
6 09	5,796	18,734	25,402	49,932
6 10	4,022	12,683	14,005	30,710
6 11	1,110	13,735	10,419	25,264
6 12	7,451	32,885	33,043	73,379
6 13	5,390	25,618	18,450	49,458
6 14	2,873	22,113	22,102	47,088
6 15	3,247	33,662	18,081	54,990
6 16	4,808	34,132	20,193	59,133
Total	181,957	794,391	974,756	1,951,104
Percent	9.3	40.7	50.0	

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

<sup>b</sup> Interpolated data for hours 0200-0600 on 27 May.

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<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 3. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolt, Kvichak River, 1988.

Date <sup>a</sup>	Mean Weight of Smolt (g)	Smolt per Count
5 22	8.1	10.2
5 23	8.1	10.2
5 24	7.8	10.6
5 25	7.6	10.9
5 26	7.9	10.5
5 27	7.9	10.5
5 28	7.9	10.5
5 29	8.1	10.2
5 30	7.8	10.6
5 31	8.0	10.4
6 01	7.5	11.0
6 02	7.8	10.6
6 03	7.5	11.1
6 04	8.0	10.4
6 05	7.5	11.1
6 06	7.3	11.3
6 07	7.3	11.3
6 08	8.1	10.2
6 09	8.1	10.2
6 10	7.8	10.6
6 11	8.4	9.9
6 12	8.2	10.1
6 13	7.7	10.8
6 14	8.2	10.2
6 15	8.2	10.2
6 16	7.8	10.6

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 4. Sockeye salmon spawning escapement, total number of smolt produced by age class, percent of total smolt production comprised by each age class, and number of smolt produced per spawner for 1956-1986 brood years, Kvichak River.

Brood Year	Total Spawning Escapement	Number of Smolt Produced					
		Age I (%)	Age II (%)	Age III (%)	Total	Per Spawner	
<u>Estimates of smolt numbers based upon fyke net catches</u>							
1956	9,443,318	3,267,274 (54)	2,777,960 (46)	0	6,045,234	0.64	
1957	2,842,810	85,916 (13)	552,603 (87)	0	638,519	0.23	
1958	534,785	61,400 (86)	10,126 (14)	0	71,526	0.13	
1959	680,000	26,038 (27)	72,180 (73)	0	98,218	0.14	
1960	14,630,000	1,130,820 (22)	4,116,093 (78)	0	5,246,913	0.36	
1961	3,705,849	113,338 ( 7)	1,603,464 (93)	0	1,716,802	0.46	
1962	2,580,884	458,122 (21)	1,748,178 (79)	0	2,206,300	0.86	
1963	338,760	64,377 (73)	23,377 (27)	0	87,754	0.27	
1964	957,120	252,384 (53)	222,528 (47)	0	474,912	0.50	
1965	24,325,926	2,866,214 (34)	5,475,362 (66)	0	8,341,576	0.34	
1966	3,775,184	648,321 (55)	541,017 (45)	0	1,189,338	0.32	
1967	3,216,208	594,327 (67)	298,282 (33)	0	892,609	0.28	
1968	2,557,440	185,356					
<u>Estimates of smolt numbers based upon sonar techniques</u>							
1968			5,959,383	0	-	-	
1969	8,394,204	85,723,430 (61)	54,159,340 (39)	0	139,882,770	16.66	
1970	13,935,306	464,219 (<1)	191,842,930 (98)	2,918,768 (1)	195,225,917	14.01	
1971	2,387,392	5,123,400 (19)	21,423,246 (81)	0	26,546,646	11.12	
1972	1,009,962	2,740,610	-	-	-	-	
1973	226,554	-	3,031,287	0	-	-	
1974	4,433,844	108,356,892 (49)	114,269,848 (51)	0	222,626,740	50.21	
1975	13,140,450	78,308,251 (27)	213,364,470 (73)	0	291,672,721	22.20	
1976	1,965,282	32,226,544 (55)	26,423,348 (45)	0	58,649,892	29.84	
1977	1,341,144	28,758,191 (73)	10,410,467 (27)	0	39,168,658	29.21	
1978	4,149,288	182,442,540 (85)	32,294,536 (15)	0	214,737,076	51.75	
1979	11,218,434	219,928,232 (71)	89,300,703 (29)	0	309,228,935	27.56	
1980	17,505,268	150,421,026 (62)	76,244,773 (38)	0	199,172,858	12.95	
1981	1,754,358	6,549,125 (15)	37,595,987 (85)	0	44,145,112	25.16	
1982	1,134,840	51,893,988 (96)	1,937,408 ( 4)	2,065	53,833,461	47.44	
1983	3,569,982	23,590,443 (31)	53,260,693 (69)	123,975	76,975,111	21.56	
1984	10,490,670	83,470,460 (20)	331,384,545 (80)	43,135	414,898,140	39.55	
1985	7,211,046	11,178,398 (11)	87,004,194 (89)		98,182,592	13.62 <sup>b</sup>	
1986	1,179,322	13,126,363					

<sup>a</sup> Percent of total smolt production

<sup>b</sup> Preliminary total

Table 5. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt) for 1952-1986 brood years, Kvichak River.

Brood Year	Total Spawning Escapement	Age I			Age II		
		Number of Smolt	Adult <sup>a</sup> Returns	Adult Returns per Smolt	Number of Smolt	Adult <sup>a</sup> Returns	Adult Returns per Smolt
<u>Estimates of smolt numbers based upon fyke net catches</u>							
1952	-	-			241,870	3,610,258	14.93
1953	-	18,198	152,165	8.36	47,373	424,627	8.96
1954	-	30,287	109,965	3.63	8,654	659,246	76.18
1955	-	22,253	351,240	15.78	66,679	1,132,813	16.99
1956	9,443,318	3,267,274	31,253,977	9.57	2,777,960	7,773,131	2.80
1957	2,842,810	85,916	488,844	5.69	552,603	3,591,552	6.50
1958	534,785	61,400	124,250	2.02	10,126	161,253	15.92
1959	680,000	26,038	328,287	12.61	72,180	217,593	3.01
1960	14,630,000	1,130,820	1,877,221	1.66	4,116,093	53,360,190	12.96
1961	3,705,849	113,338	524,416	4.63	1,603,464	2,971,816	1.85
1962	2,580,884	458,122	256,253	0.56	1,748,178	5,083,162	2.91
1963	338,760	64,377	98,571	1.53	23,377	1,008,242	43.13
1964	957,120	252,384	2,647,042	10.49	222,528	3,093,042	13.90
1965	24,325,926	2,866,214	10,349,415	3.61	5,475,362	34,671,692	6.33
1966	3,775,184	648,321	1,594,186	2.46	541,017	4,657,432	8.61
1967	3,216,208	594,327	621,690	1.05	298,282	900,307	3.02
1968	2,557,440	185,356	332,177	1.79	-	-	-
<u>Estimates of smolt numbers based upon sonar techniques</u>							
1968	2,557,440	-			5,959,383	209,105	0.04
1969	8,394,204	85,723,430	449,876	0.01	54,159,340	4,823,046	0.09
1970	13,935,306	464,219	56,805	0.12	191,842,930	15,350,282	0.08
1971	2,387,392	5,123,400	337,402	0.07	21,423,246	2,490,225	0.12
1972	1,009,962	2,740,610	436,664	0.16	-	1,504,342	-
1973	226,554	-	1,607,253	-	3,031,287	818,392	0.27
1974	4,433,844	108,356,892	8,353,688	0.08	114,269,848	17,797,272	0.16
1975	13,140,450	78,308,251	6,919,726	0.09	213,364,470	31,164,419	0.15
1976	1,965,282	32,226,544	6,132,602	0.19	26,423,348	4,431,287	0.17
1977	1,341,144	28,758,191	2,910,136	0.10	10,410,467	307,905	0.03
1978	4,149,288	182,442,540	2,989,871	0.02	32,294,536	2,169,833	0.07
1979	11,218,434	219,928,232	20,631,921	0.09	89,300,703	21,194,617	0.24
1980	22,505,268	150,421,026	4,536,972	0.03	76,244,773	8,527,417	0.11
1981	1,754,358	6,549,125	1,034,266	0.16	37,595,987	1,097,260	0.03
1982	1,134,840	51,893,988	991,104	0.02	1,937,408	662,863	0.34
1983	3,569,982	23,590,443	11,613,889	0.49	53,260,693	1,771,787	0.03
1984	10,490,670	83,470,460	4,476,802	0.05	331,384,545	17,010,478	0.05 <sup>b</sup>
1985	7,211,046	11,178,398	1,060,425	0.09 <sup>b</sup>	87,004,194	29,530	0.00 <sup>b</sup>
1986	1,179,322	13,126,363	0	0.00 <sup>b</sup>	-	-	-

<sup>a</sup> Includes estimates of returns through 1989.

<sup>b</sup> Future adult returns may increase these values.

Table 6. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Kvichak River, 1988.

Date <sup>a</sup>	Age I					Age II					Age III				
	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size
5 23	87	8.5	5.7	2.61	5	99	13.0	8.2	3.43	101					0
5 24	85	6.3	5.2	1.08	9	98	13.8	8.1	3.92	94					0
5 25	83	8.1	4.7	1.23	15	98	15.3	7.9	3.62	64					0
5 26	85		5.2		1	96	7.9	7.2	2.04	19					0
5 27	80	8.1	4.4	1.67	6	98	15.4	8.2	3.95	57	114		11.8		1
5 28	83	4.9	5.0	0.48	6	100	14.2	8.3	3.68	73					0
5 29	87	6.1	5.5	1.59	8	99	16.0	8.1	3.74	99	97		7.7		1
5 30	86	9.6	5.5	1.66	10	98	16.1	8.0	3.35	62					0
5 31	84	6.1	4.9	1.22	14	99	16.2	7.9	3.72	104	118		12.4		1
6 01	88	12.8	5.8	2.41	23	98	15.0	7.8	3.35	96	98		7.6		1
6 02	92	8.3	6.0	1.17	5	97	15.8	7.6	3.52	95					0
6 03	87	9.7	5.9	1.80	21	97	15.8	7.8	3.28	93					0
6 04	85	10.1	5.2	1.81	7	100	16.5	8.2	4.00	72					0
6 05	86	6.1	5.8	1.15	10	98	18.4	8.0	4.09	65	109	5.9	9.5	1.07	2
6 06	86	9.4	5.3	1.84	18	97	9.9	7.3	2.02	16					0
6 07	84	9.0	5.0	1.53	32	100	16.5	8.1	3.39	76					0
6 08	84	11.5	5.4	2.51	8	100	16.0	8.9	4.41	61					0
6 09	87	5.7	5.8	1.70	13	101	17.7	8.5	4.10	107					0
6 10	87	6.3	5.8	0.92	12	100	15.6	8.4	3.73	107					0
6 11	90	5.8	6.2	0.93	10	103	14.9	8.8	3.89	70					0
6 12	89	9.3	6.2	2.15	24	102	16.7	9.2	3.95	94					0
6 13	90	12.2	6.7	3.24	33	99	20.3	8.4	4.31	66					0
6 14	87	5.6	6.3	1.11	4	102	17.8	9.6	4.46	46					0
6 15	88	16.2	6.0	3.25	26	103	21.8	9.4	6.34	84					0
6 16	89	9.2	6.2	2.21	44	102	16.4	9.2	4.18	52					0
Totals					364					1,873					6
Means	86		5.6			99		8.3			107		9.8		

<sup>a</sup> Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.



Table 7. Age composition of total migration, and mean fork length and weight by age class for sockeye salmon smolt, Kvichak River, 1955-1988.

Year of Migration	Age I			Age II			Age III			Total Estimate	References
	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)		
1955 <sup>a</sup>	7	89	-	93	-	-	0	-	-	260,068	Paulus and Parker (1974)
1956	39	92	-	61	116	-	0	-	-	77,660	"
1957	72	96	7.3	28	120	14.4	0	-	-	30,907	"
1958	98	84	4.6	2	114	-	0	-	-	3,333,953	"
1959	3	80	-	97	99	7.6	0	-	-	2,863,876	"
1960	10	91	6.3	90	108	10.3	0	-	-	614,003	"
1961	72	92	6.8	28	117	13.1	0	-	-	36,164	"
1962	94	82	4.3	6	110	9.9	0	-	-	1,203,000	"
1963	3	83	4.8	97	98	7.5	0	-	-	4,229,431	Marriott (1965)
1964	22	87	5.2	78	108	9.8	0	-	-	2,061,586	Pennoyer and Seibel (1965)
1965	4	90	6.8	96	109	11.3	0	-	-	1,812,555	Pennoyer (1966)
1966	92	94	7.4	8	114	12.6	0	-	-	275,761	Pennoyer and Stewart (1967)
1967	93	86	5.9	7	118	14.2	0	-	-	3,088,742	Pennoyer and Stewart (1969)
1968	11	88	5.5	89	104	9.2	0	-	-	6,123,683	Paulus and McCurdy (1969)
1969	52	92	5.7	48	109	10.6	0	-	-	1,135,344	McCurdy and Paulus (1972)
1970	38	91	6.0	62	110	11.0	0	-	-	483,638	Paulus and McCurdy (1972)
1971	93	90	5.8	7	111	11.1	0	-	-	91,682,813	Russell (1972)
1972	1	80	4.2	99	106	10.0	0	-	-	54,623,559	Parker (1974a)
1973	3	86	5.1	97	97	8.3	0	-	-	196,966,331	Parker (1974b)
1974	9	96	8.3	79	111	13.1	12	124	17.5	27,082,626	Krasnowski (1975)
1975	63	98	8.4	37	122	16.4	0	-	-	15,632,531	Randall (1976)
1976	97	88	5.8	3	121	14.2	0	-	-	111,388,180	Randall (1977)
1977	38	86	5.5	62	106	10.1	0	-	-	192,578,099	Randall (1978)
1978	12	88	6.0	88	97	7.8	0	-	-	245,591,014	Yuen (1980a)
1979	51	90	6.0	49	109	10.3	0	-	-	55,181,540	Yuen (1980b)
1980	94	88	5.9	6	110	10.7	0	-	-	192,853,007	Yuen and Wise (1982)
1981	89	85	5.4	11	108	10.2	0	-	-	252,222,769	Bergstrom and Yuen (1981)
1982	58	84	5.1	39	103	9.1	0	-	-	239,721,729	Bill (1984)

-Continued-

Table 7. (p 2 of 2)

Year of Migration	Age I			Age II			Age III			Total Estimate	References
	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)		
1983	8	80	4.9	92	98	8.5	0	-	-	82,793,899	Bill et al. (1987)
1984	58	90	6.8	42	104	10.0	0	-	-	89,489,975	Bill (1986)
1985	92	85	5.3	8	102	9.2	0	-	-	25,527,851	Bill (1986)
1986	61	84	5.5	39	107	10.4	0	102	9.1	136,733,218	Bue et al. (1988)
1987	3	82	4.5	97	96	7.0	0	97	8.5	342,686,918	Cross et al. (1990)
Mean		88	5.8		112	10.6		108	11.7		
1988	13	86	5.6	87	99	8.3	0	107	9.8	100,173,692	

<sup>a</sup> Estimates of smolt numbers for 1955-1970 based on fyke net catches, estimates of smolt numbers for 1971-988 based on sonar techniques.

Table 8. Mean fork length and estimated weight, by estimated age of sockeye salmon smolt length frequencies, Kvichak River, 1988.

Date <sup>a</sup>	Estimated Age I				Estimated Age II			
	Mean Length (mm)	Std. Error	Estimated Mean Weight (g)	Sample Size	Mean Length (mm)	Std. Error	Estimated Mean Weight (g)	Sample Size
5 23 <sup>b</sup>	84	9.2	5.1	34	99	26.3	8.2	523
5 24	85	10.0	5.2	63	98	23.1	7.9	540
5 25	81	15.7	4.7	101	99	21.2	8.0	325
5 26	86	4.0	5.4	9	97	14.3	7.8	91
5 27	82	11.9	4.7	35	98	20.2	7.9	323
5 28	81	13.1	4.6	37	99	21.5	8.1	300
5 29	85	9.5	5.2	51	100	25.2	8.2	545
5 30	84	9.5	5.1	64	98	21.7	7.9	390
5 31	84	9.8	5.1	55	99	22.7	8.1	574
6 01	84	10.5	5.1	130	97	20.9	7.8	599
6 02	85	11.5	5.2	43	98	21.3	7.8	450
6 03	84	9.1	5.1	109	97	20.6	7.7	505
6 04	84	9.4	5.2	59	99	22.7	8.1	349
6 05	85	9.6	5.2	90	96	19.9	7.6	378
6 06	84	5.9	5.1	22	97	15.4	7.7	77
6 07	84	11.0	5.0	132	99	23.5	8.2	400
6 08	85	8.2	5.3	32	99	23.8	8.2	314
6 09	86	8.4	5.3	86	100	28.9	8.4	543
6 10	84	9.4	5.2	105	98	22.9	8.0	537
6 11	86	5.4	5.4	35	100	25.1	8.4	385
6 12 <sup>c</sup>	85	10.5	5.2	99	101	29.2	8.6	526
6 13	83	17.0	5.0	139	99	30.4	8.1	382
6 14	87	15.3	5.9	136	100	18.1	8.6	210
6 15	87	15.2	5.9	142	102	26.2	9.1	440
6 16	87	23.4	6.0	267	101	24.7	8.8	348
Totals				2,075				10,054
Means	85		5.2		99		8.1	

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

<sup>b</sup> Length-weight parameters by age group and discriminating length used to separate ages for May 23 through June 10 were:  
age I  $a = -11.30$   $b = 2.91$   $r^2 = 0.82$   $n = 223$   
age II  $a = -9.32$   $b = 2.48$   $r^2 = 0.74$   $n = 1,461$   
discriminating length = 89.74

<sup>c</sup> Length-weight parameters by age group and discriminating length used to separate ages for June 11 through June 17 were:  
age I  $a = -11.27$   $b = 2.91$   $r^2 = 0.74$   $n = 140$   
age II  $a = -9.17$   $b = 2.46$   $r^2 = 0.78$   $n = 411$   
discriminating length = 93.05

Table 9. Climatological and hydrological observations made at sockeye salmon smolt counting site, Kvichak River, 1988.

Date	Cloud Cover <sup>a</sup>		Wind Velocity (km/hr)		Air Temp. (°C)		Mean Water Temp. (°C) <sup>b</sup>	Precipitation (mm)	Water Clarity <sup>c</sup>
	0800 hours	2000 hours	0800 hours	2000 hours	0800 hours	2000 hours			
5 17	2	2	calm	0-10	-	-	3.0	0.0	clear
5 18	2	2	5-15 NE	-	-	-	3.0	0.0	clear
5 19	2	3	0-5 SW	-	-	-	3.0	0.0	clear
5 20	4	2	5-7 SW	-	-	-	3.0	0.3	clear
5 21	5	2	5-8 NE	-	-	-	3.0	0.0	clear
5 22	2	2	5-8 SW	5-10 SW	-	-	3.8	0.0	clear
5 23	1	3	calm	0-5 SW	4.0	-	4.0	trace	clear
5 24	1	1	0-10 E	0-5 E	7.0	-	4.8	0.0	clear
5 25	2	2	10-20 E	5-10 E	6.0	12.0	5.8	0.0	clear
5 26	4	2	5-10 E	5-10 E	7.0	10.0	6.5	0.0	clear
5 27	2	2	0-5 SW	calm	4.0	10.0	5.6	1.3	clear
5 28	4	3	10-15 SW	calm	4.0	8.0	6.7	0.5	clear
5 29	3	2	5-10 E	calm	5.0	14.0	7.0	0.8	clear
5 30	2	2	0-5 E	0-5 E	6.0	9.0	6.5	3.1	clear
5 31	4	4	10-20 SW	calm	4.0	7.5	6.0	0.6	clear
6 01	1	1	calm	calm	6.0	12.0	6.3	trace	clear
6 02	3	1	calm	0-5 NW	6.0	16.0	6.8	0.8	clear
6 03	3	1	5-10 SW	5-10 SW	5.5	15.0	7.2	trace	clear
6 04	1	1	5-10 SW	5-10 SW	3.0	17.0	7.0	0.0	clear
6 05	4	4	0-5 E	0-5 E	8.0	10.0	6.8	13.0	clear
6 06	4	4	0-5 SW	5-10 W	7.0	11.0	7.1	7.2	clear
6 07	3	2	calm	calm	4.5	19.0	7.3	0.0	clear
6 08	3	2	0-2 SW	calm	7.0	14.0	7.6	0.0	clear
6 09	3	4	0-5 E	0-5 E	10.0	10.0	8.0	2.8	clear
6 10	4	4	0-2 E	calm	7.5	10.0	8.0	2.8	murky
6 11	4	2	0-2 SW	calm	8.0	20.0	8.3	0.3	clear
6 12	3	2	calm	10-15 E	7.0	21.0	8.4	0.0	clear
6 13	2	2	0-5 E	10-15 E	8.0	20.0	8.7	trace	clear
6 14	2	2	15-20 E	20-25 E	10.5	17.0	8.9	0.0	clear
6 15	1	1	0-5 E	5-10 E	10.5	22.0	9.1	0.0	murky
6 16	1	3	0-5 E	5-10 E	10.0	18.0	9.1	0.0	clear
6 17	3	-	calm	-	11.5	-	-	-	-

- <sup>a</sup> 1 = cloud cover not more than 1/10  
 2 = cloud cover not more than 1/2  
 3 = cloud cover more than 1/2  
 4 = completely overcast  
 5 = fog

- <sup>b</sup> mean of water temperature readings taken at 0400, 0800, 1200, 1600, and 2400 hours

- <sup>c</sup> water clarity at 0800 hours

Table 10. Water temperatures at sockeye salmon smolt counting site, Kvichak River, 1963-1988.

Year	Sample Period	Water Temperature (°C)			References
		Minimum	Maximum	Mean	
1963	May 16 - Jun 14	2.2	8.9	5.5	Marriott (1965)
1964	May 18 - Jun 14	0.0	5.6	2.6	Pennoyer and Seibel (1965)
1965	May 17 - Jun 11	0.0	8.9	4.4	Pennoyer (1966)
1966	May 16 - Jun 26	0.0	11.1	4.7	Pennoyer and Stewart (1967)
1967	May 17 - Jun 20	1.1	9.4	6.9	Pennoyer and Stewart (1969)
1968	May 12 - Jun 12	3.3	8.3	5.4	Paulus and McCurdy (1969)
1969	May 16 - Jun 18	0.3	7.8	3.9	McCurdy and Paulus (1972)
1970	May 13 - Jun 07	2.8	11.1	6.8	Paulus and McCurdy (1972)
1971	May 17 - Jun 20	1.1	3.3	2.4	Russell (1972)
1972	May 18 - Jun 18	0.6	5.0	2.9	Parker (1974a)
1973	May 15 - Jun 14	2.9	8.9	4.9	Parker (1974b)
1974	May 13 - Jun 09	3.0	8.0	6.2	Krasnowski (1975)
1975	May 17 - Jun 15	2.0	8.0	3.8	Randall (1976)
1976	May 18 - Jun 19	2.0	9.5	3.9	Randall (1977)
1977	May 17 - Jun 14	3.0	9.5	6.4	Randall (1978)
1978	May 19 - Jun 09	5.0	11.0	7.6	Yuen (1980a)
1979	June 1 - Jun 10	8.0	10.0	8.6	Yuen (1980b)
1980	May 16 - Jun 18	1.5	9.0	5.5	Bergstrom and Yuen (1981)
1981	May 15 - Jun 09	7.0	10.0	8.2	Yuen and Wise (1982)
1982	May 14 - Jun 15	2.5	8.5	4.9	Bill (1984)
1983	May 19 - Jun 14	5.2	10.5	7.9	Bill et al. (1987)
1984	May 19 - Jun 11	5.5	10.0	7.9	Bill (1986)
1985	May 23 - Jun 20	2.0	7.0	4.6	Bill (1986)
1986	May 18 - Jun 12	1.0	7.0	4.6	Bue et al. (1988)
1987	May 21 - Jun 13	4.5	9.0	6.7	Cross et al. (1990)
Mean		2.7	8.6	5.5	
1988	May 17 - June 17	3.0	11.0	7.1	

Table 11. Sonar counts recorded from three arrays each with 10 transducers at the sockeye salmon smolt counting site on the Egegik River, 1988.

Sonar Counts				
Transducer Array				
Date <sup>a</sup>	Inshore	Center	Offshore	Total
5 18	187	1,886	2,492	4,565
5 19	1,170	1,294	3,035	5,499
5 20	0	3	27	30
5 21	0	51	0	51
5 22	16,946	48,807	32,682	98,435
5 23	66,916	162,176	103	230,041
5 24	27,548	383,455	335,987	746,990
5 25	38,054	243,966	153,359	435,379
5 26	13,697	74,390	54,967	143,054
5 27	37,659	89,052	125,187	251,898
5 28	5,661	134,947	325,279	465,887
5 29	12,322	38,127	29,747	80,196
5 30	5,047	37,376	44,159	86,582
5 31	70,231	26,026	18,776	115,033
6 01	14,973	4,111	1,784	20,868
6 02	23,267	78,164	108,011	209,442
6 03	17,310	22,446	21,502	61,258
6 04	12,505	11,552	10,830	34,887
6 05	25,932	70,513	52,136	148,581
6 06	6,482	24,784	38,833	70,099
6 07	25,482	9,793	2,159	37,434
6 08	7,178	1,416	1,895	10,489
6 09	6,181	0	115,35	30,347
6 10	19,583	7,544	5,555	32,682
6 11	2,689	8,186	9,439	20,314
6 12	3,435	7,152	5,979	16,566
6 13	4,294	1,372	592	6,258
Total	464,749	1,488,589	1,396,050	3,362,865
Percent	13.8	44.3	41.5	

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

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<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 13. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolt, Egegik River, 1988.

Date <sup>a</sup>	Mean Weight of Smolt (g)	Smolt per Count
5 18	13.1	3.2
5 19	13.1	3.2
5 20	13.1	3.2
5 21	13.1	3.2
5 22	13.1	3.2
5 23	13.1	3.2
5 24	13.1	3.2
5 25	14.5	2.9
5 26	12.3	3.4
5 27	12.3	3.4
5 28	12.3	3.4
5 29	11.8	3.5
5 30	13.1	3.2
5 31	12.5	3.3
6 01	13.9	3.0
6 02	12.1	3.4
6 03	11.2	3.7
6 04	11.2	3.7
6 05	11.2	3.7
6 06	11.6	3.6
6 07	11.1	3.8
6 08	10.0	4.2
6 09	10.0	4.2
6 10	10.0	4.2
6 11	10.0	4.2
6 12	10.0	4.2
6 13	10.0	4.2

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.



Table 14. Sockeye salmon spawning escapement, total number of smolt produced by age class, percent of total smolt production comprised by each age class, and number of smolt produced per spawner for 1978-1986 brood years, Egegik River.

Brood Year	Total Spawning Escapement	Number of Smolt Produced				
		Age I (%) <sup>a</sup>	Age II (%) <sup>a</sup>	Age III	Total	Per Spawner
1978	895,698	-	-	225,522	-	-
1979	1,032,042	-	14,287,075	0	-	-
1980	1,060,860	49,457,563 (75)	16,524,563 (25)	197,429	66,179,555	62.38
1981	694,680	2,242,326 (7)	32,235,734 (93)	52,852	34,530,912	49.71
1982	1,034,628	17,234,269 (60)	11,434,848 (40)	564	28,669,681	27.71
1983	792,282	54,585,828 (65)	29,984,140 (35)	85,087	84,655,055	106.84
1984	1,165,320	14,016,441 (24)	45,386,536 (76)	80,931	59,483,908	51.05
1985	1,095,204	4,397,087 (26)	12,758,135 (74)		17,155,222	15.70 <sup>b</sup>
1986	1,151,320	36,122,149				

<sup>a</sup> Percent of total smolt production

<sup>b</sup> Preliminary, age-III outmigration in 1989 may increase this total.

Table 15. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt) for 1978-1986 brood years, Egegik River.

Brood Year	Total Spawning Escapement	Age I			Age II			Age III		
		Number of Smolt	Adult <sup>a</sup> Returns	Adult Returns per Smolt	Number of Smolt	Adult <sup>a</sup> Returns	Adult Returns per Smolt	Number of Smolt	Adult <sup>a</sup> Returns	Adult Returns per Smolt
1978	895,698	-	907,413		-	8,310,922		225,522	33,756	0.15
1979	1,032,042	-	1,246,161		14,287,075	4,737,895	0.33	0	0	0.00
1980	1,060,860	49,457,563	3,027,613	0.06	16,524,563	5,502,662	0.33	197,429	7,888	0.04
1981	694,680	2,242,326	1,532,938	0.68	32,235,734	4,875,574	0.15	52,852	16,104	0.30
1982	1,034,628	17,234,269	2,901,187	0.17	11,434,848	3,442,382	0.30 <sup>b</sup>	564	11,993	21.26 <sup>b</sup>
1983	792,282	54,585,828	4,507,190	0.08	29,984,140	5,942,245	0.20 <sup>b</sup>	85,087	22,644	0.27 <sup>b</sup>
1984	1,165,320	14,016,441	1,561,205	0.11 <sup>b</sup>	45,386,536	723,961	0.02 <sup>b</sup>	80,931	2,646	0.03 <sup>b</sup>
1985	1,095,192	4,397,087	570,256	0.13 <sup>b</sup>	12,758,135	31,997	0.00 <sup>b</sup>			
1986	1,151,320	36,122,149	1623	0.00 <sup>b</sup>						

<sup>a</sup> Includes estimates of returns through 1989.

<sup>b</sup> Future adult returns may increase these values.

Table 16. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Egegik River, 1988.

Date <sup>a</sup>	Age I					Age II					Age III				
	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size
5 23	106	8.1	10.4	2.52	13	117	6.8	13.4	1.59	3					0
5 24	107	12.1	10.7	3.56	71	123	19.3	15.4	6.15	28	144		23.3		1
5 25	105	13.0	10.0	3.74	51	121	13.6	15.0	5.72	8	125		16.5		1
5 27	105	12.2	10.8	3.57	84	110	7.2	12.2	2.24	5	117		13.2		1
5 28	104	11.2	10.5	3.78	89	119		14.8		1	135		20.4		1
5 29	105	10.7	10.3	3.41	87	115	20.1	13.5	6.66	3					0
5 30	104	10.2	10.9	2.75	83	119	18.3	15.5	6.41	15	137	1.8	22.2	0.36	2
5 31	105	12.8	10.7	4.11	72	125	22.1	17.4	8.84	23	139	8.5	22.0	3.71	5
6 01	104	12.5	10.8	3.92	65	129	28.6	19.8	10.79	32	143	4.7	25.5	1.77	3
6 02	103	11.2	10.6	3.32	80	124	28.8	17.1	11.14	20					0
6 04	100	10.4	9.9	3.28	88	117	25.7	16.4	10.48	10	143	5.4	27.6	2.44	2
6 05	102	10.3	9.7	3.00	39	119		14.3		1					0
6 06	104	13.8	10.5	4.73	95	112	6.5	12.7	1.77	4	140		20.3		1
6 07	104	18.4	10.5	5.47	85	123	15.6	16.2	5.47	15					0
6 09	101	13.2	9.3	3.99	99	119		14.1		1					0
6 10	101	12.7	8.9	3.47	71	109	9.2	11.2	4.13	4					0
6 11	101	10.9	9.2	3.18	59	115		13.0		1					0
6 12	100	17.2	9.8	5.10	96	98	4.3	9.4	0.96	3					0
6 13	100	11.1	9.5	3.18	53	102	0.6	10.6	0.36	2					0
Totals					1,380					198					17
Means	103		10.2			117		14.3			136		21.2		

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 17. Mean fork length and weight of sockeye salmon smolt sampled from the Egegik River, 1939-1988.

Year of Migration	Sample Dates	Sample Size	Age I		Age II		Age III		References
			Mean Length	Mean Weight	Mean Length	Mean Weight	Mean Length	Mean Weight	
1939	-	-	96	-	105	-	-	-	USF&WS (unpublished)
1956	-	386	101	-	116	-	123	-	"
1957	-	236	107	-	120	-	130	-	"
1959	-	281	99	-	116	-	123	-	"
1960	-	159	106	-	115	-	140	-	"
1969	-	67	99	-	119	-	115	-	Paulus (1972)
1977	May 27 - May 29	299	110	11.3	116	13.3	-	-	ADF&G (unpublished)
1978	May 19 - May 22	319	104	10.1	122	15.4	130	18.1	Huttunen (1980)
1981	May 15 - Jun 06	549	105	9.1	122	16.6	128	19.1	Bue (1982)
1982	May 27 - Jun 15	881	104	9.2	130	17.1	145	23.5	Bue (1984)
1983 <sup>a</sup>	May 17 - Jun 09	2,631	101	9.3	116	13.6	-	-	Fried et al. (1987)
1984 <sup>a</sup>	May 10 - Jun 10	3,602	106	10.1	112	12.2	134	20.2	Fried et al. (1986)
1985 <sup>a</sup>	May 24 - Jun 05	5,427	106	10.4	123	16.8	138	24.1	Bue (1986)
1986	May 18 - Jun 11	1,120	101	9.0	122	15.7	140	22.6	Bue et al. (1988)
1987	May 18 - Jun 13	1,953	107	11.6	114	14.1	128	18.9	Cross et al. (1990)
Mean			103	10.0	118	15.0	131	20.9	
1988	May 18 - Jun 13	1,595	103	10.2	117	14.3	136	21.2	

<sup>a</sup> Age, weight, and length samples pooled with estimated weight by age from length samples.

Table 18. Mean fork length and estimated weight, by estimated age of sockeye salmon smolt length frequencies, Egegik River, 1988.

Date <sup>a</sup>	Estimated Age I				Estimated Age II			
	Mean Length (mm)	Std. Error	Estimated Mean Weight (g)	Sample Size	Mean Length (mm)	Std. Error	Estimated Mean Weight (g)	Sample Size
5 23	104	4.4	10.7	21	119	30.3	15.7	472
5 24 <sup>b</sup>	106	13.9	11.8	285	126	32.6	17.5	217
5 25	106	14.1	11.9	219	130	37.4	19.0	285
5 27	104	18.0	11.3	374	126	29.4	17.3	119
5 28	105	16.5	11.5	417	123	28.6	16.6	119
5 29	104	17.4	11.2	453	125	26.0	17.1	70
5 30	105	15.6	11.5	329	128	35.2	18.4	155
5 31	104	16.6	11.2	407	127	30.6	17.8	111
6 01	105	14.2	11.6	307	129	37.1	18.8	175
6 02	104	17.9	11.2	425	126	29.8	17.4	90
6 04	102	13.8	10.8	216	128	23.7	18.4	38
6 05	102	18.9	10.8	470	124	24.6	16.9	48
6 06	103	19.1	11.0	355	124	29.1	17.0	48
6 07	102	19.0	10.7	455	122	15.8	15.9	20
6 09 <sup>c</sup>	102	13.8	9.6	208	118	17.3	14.2	20
6 11	101	11.6	9.4	75	115	12.1	13.4	12
6 12	99	6.8	8.9	8				0
Totals				5,003				1,527
Means	103		10.9		125		17.0	

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

<sup>b</sup> Length-weight parameters by age group and discriminating length used to separate ages for May 24 through June 8 were:  
age I      a = - 9.13    b = 2.48    r<sup>2</sup> = 0.71    n = 1002  
age II     a = - 9.82    b = 2.62    r<sup>2</sup> = 0.86    n = 187  
discriminating length = 112.60

<sup>c</sup> Length-weight parameters by age group and discriminating length used to separate ages for June 9 through June 14 were:  
age I      a = -10.23    b = 2.70    r<sup>2</sup> = 0.75    n = 377  
age II     a = - 8.90    b = 2.42    r<sup>2</sup> = 0.78    n = 10  
discriminating length = 110.71

Table 19. Climatological and hydrological observations made at sockeye salmon smolt counting site, Egegik River, 1988.

Date	Cloud Cover <sup>a</sup>		Wind Velocity (km/hr)		Air Temp. (°C)		Water Temp. (°C)		Precipitation (mm)	Water Clarity
	0800 hours	2000 hours	0800 hours	2000 hours	Min.	Max.	0800 hours	2000 hours		
5 19	4	3	E	5 W	3.3	15.5	4.2	5.5	0.0	clear
5 20	5	3	SE	10 NE	5.5	14.5	4.0	5.9	1.3	clear
5 21	4	1	5 W	10 NW	7.0	11.0	3.9	6.9	0.0	clear
5 22	5	3	E	10 NE	7.0	14.5	3.0	6.5	0.0	clear
5 23	4	3	5 S	10 SE	7.0	18.0	4.5	6.1	1.8	clear
5 24	1	2	NE	10-15 E	4.5	12.0	4.5	7.0	0.0	clear
5 25	4	3	15 NE	15 E	8.5	14.5	5.5	7.0	0.0	clear
5 26	4	3	15 NE	15 E	8.5	15.0	5.0	5.8	0.5	clear
5 27	3	3	SW	20-25 W	5.5	11.0	4.9	6.5	0.0	clear
5 28	4	3	5 S	5-10 W	4.5	13.5	6.0	7.5	0.0	clear
5 29	4	4	calm	calm	4.5	12.0	5.5	6.0	5.6	clear
5 30	3	4	calm	5 W	4.5	11.0	6.0	7.0	3.3	clear
5 31	4	4	5-10 SE	5 SE	5.0	15.0	5.0	5.9	2.3	clear
6 01	3	3	SW	5 W	5.0	10.5	4.9	6.5	0.3	clear
6 02	2	3	0-5 E	10-15 NW	5.0	15.0	4.9	6.9	0.0	clear
6 03	4	1	5-10 SW	5-10 W	5.0	16.0	5.0	8.0	0.0	clear
6 04	3	3	5-10 E	20-25 E	6.5	13.5	6.0	7.5	0.0	clear
6 05	4	4	35-40 E	20-25 E	6.5	12.0	5.5	6.0	0.3	clear
6 06	5	3	5 SW	5 W	3.0	10.0	6.0	6.9	3.8	clear
6 07	4	3	calm	15 E	3.0	11.0	7.0	7.5	0.0	clear
6 08	4	3	15 E	20-25 E	3.0	13.5	6.9	7.0	0.0	clear
6 09	4	3	20-25 SE	20-25 E	2.0	12.0	6.0	6.0	4.8	clear
6 10	4	4	10-12 E	10 E	2.0	8.5	6.0	8.5	3.6	murky
6 11	4	3	0-2 E	1-5 E	2.0	6.5	8.0	8.5	0.0	clear
6 12	3	3	calm	10 E	6.0	15.0	7.5	10.0	0.0	clear
6 13	3	3	0-5 E	10-15 E	6.0	19.0	9.5	10.1	0.0	clear
6 14	3	-	10-15 E	-	8.0	15.0	9.5	-	-	clear

- <sup>a</sup> 1 = cloud cover not more than 1/10  
 2 = cloud cover not more than 1/2  
 3 = cloud cover more than 1/2  
 4 = completely overcast  
 5 = fog

Table 20. Water temperatures at sockeye salmon smolt counting site, Egegik River, 1981-1988.

Year	Sample Period	Water Temperature (°C)			Reference
		Minimum	Maximum	Mean	
1981	May 15 - Jun 08	5.0	9.0	7.3	Bue (1982)
1982	May 15 - Jun 16	0.0	5.0	2.9	Bue (1984)
1983	May 18 - Jun 10	5.0	9.5	7.0	Fried et al. (1987)
1984	May 17 - Jun 11	5.0	10.0	7.6	Fried et al. (1986)
1985	May 17 - Jun 12	2.5	7.5	4.2	Bue (1986)
1986	May 19 - Jun 12	2.2	7.5	7.2	Bue et al. (1988)
1987	May 18 - Jun 13	3.9	11.0	6.6	Cross et al. (1990)
Mean		3.4	8.5	6.1	
1988	May 19 - Jun 14	3.0	10.1	6.4	

Table 21. Sonar counts recorded from two arrays each with 10 transducers at the sockeye salmon smolt counting site on the Ugashik River, 1988.

Date <sup>a</sup>	Sonar Counts		
	Transducer Array		Total
	Inshore	Offshore	
5 17	2,961	39,503	42,464
5 18	3,838	30,638	34,476
5 19	4,991	97,276	102,267
5 20	1,587	4,087	5,674
5 21 <sup>b</sup>	1,347	3,352	4,699
5 22 <sup>b</sup>	6,379	52,583	58,962
5 23	10,921	205,695	216,616
5 24	9,601	152,319	161,920
5 25 <sup>b</sup>	7,394	97,316	104,710
5 26	10,184	53,300	63,484
5 27	149,012	248,492	397,504
5 28	93,007	514,713	607,720
5 29	53,603	329,283	382,886
5 30	177,832	101,910	279,742
5 31	5,646	40,650	46,296
6 01	130,751	1,190,720	132,1471
6 02	230,565	532,611	763,176
6 03 <sup>b</sup>	31,994	373,682	405,676
6 04 <sup>b</sup>	59,597	529,040	588,637
6 05	33,121	746,579	779,700
6 06	88,076	2,257,105	2,345,181
6 07	457,456	3,309,491	3,766,947
6 08	52,733	486,400	539,133
6 09	3,997	65,319	69,316
6 10	11,140	209,085	220,225
6 11	275,279	1,039,600	1,314,879
6 12	61,827	508,657	570,484
6 13	13,415	142,005	155,420
Total	1,988,254	13,361,411	15,349,665
Percent	12.9	87.1	

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

<sup>b</sup> Interpolated data for hours 1100 on May 21, 1200-1700 on May 22, 2300-0700 on May 25, 1300-1400 on June 3, and 2300-1000 on June 4.



Table 22. Daily number of sockeye salmon smolt migrating seaward, estimated with hydroacoustic equipment, Ugashik River, 1988.

Date <sup>a</sup>	Age I			Age II			Age III			All Ages	
	Number	Percent	Cumulative Total	Number	Percent	Cumulative Total	Number	Percent	Cumulative Total	Daily Total	Cumulative Total
5 17	351,942	67.0	351,942	173,031	33.0	173,031	0	0.0	0	524,973	524,973
5 18	226,624	58.3	578,566	162,163	41.7	335,194	0	0.0	0	388,787	913,760
5 19	655,209	58.3	1,233,775	468,841	41.7	804,035	0	0.0	0	1,124,050	2,037,810
5 20	34,659	58.3	1,268,434	24,801	41.7	828,836	0	0.0	0	59,460	2,097,270
5 21	28,815	58.3	1,297,249	20,619	41.7	849,455	0	0.0	0	49,434	2,146,704
5 22	322,927	58.3	1,620,176	231,074	41.7	1,080,529	0	0.0	0	554,001	2,700,705
5 23	1,427,299	57.5	3,047,475	1,054,528	42.5	2,135,057	0	0.0	0	2,481,827	5,182,532
5 24	1,855,492	82.0	4,902,967	408,407	18.0	2,543,464	0	0.0	0	2,263,899	7,446,431
5 25	1,245,351	82.9	6,148,318	257,425	17.1	2,800,889	0	0.0	0	1,502,776	8,949,207
5 26	509,670	65.7	6,657,988	265,847	34.3	3,066,736	0	0.0	0	775,517	9,724,724
5 27	2,893,150	61.5	9,551,138	1,808,101	38.5	4,874,837	0	0.0	0	4,701,251	14,425,975
5 28	3,933,918	57.4	13,485,056	2,912,388	42.5	7,787,225	9,598	0.1	9,598	6,855,904	21,281,879
5 29	3,884,094	76.0	17,369,150	1,226,556	24.0	9,013,781	0	0.0	9,598	5,110,650	26,392,529
5 30	2,613,351	66.5	19,982,501	1,317,682	33.5	10,331,463	0	0.0	9,598	3,931,033	30,323,562
5 31	257,586	53.0	20,240,087	228,425	47.0	10,559,888	0	0.0	9,598	486,011	30,809,573
6 01	2,453,480	74.1	32,693,567	4,357,373	25.9	14,917,261	0	0.0	9,598	16,810,853	47,620,426
6 02	8,977,827	82.2	41,671,394	1,948,091	17.8	16,865,352	0	0.0	9,598	10,925,918	58,546,344
6 03	3,293,466	69.4	44,964,860	1,452,846	30.6	18,318,198	0	0.0	9,598	4,746,312	63,292,656
6 04	6,316,541	80.9	51,281,401	1,496,125	19.2	19,814,323	0	0.0	9,598	7,812,666	71,105,322
6 05	8,592,265	82.3	59,873,666	1,850,449	17.7	21,664,772	0	0.0	9,598	10,442,714	81,548,036
6 06	30,477,428	91.7	90,351,094	2,751,342	8.3	24,416,114	0	0.0	9,598	33,228,770	114,776,806
6 07	51,100,374	91.6	141,451,468	4,716,528	8.5	29,132,642	0	0.0	9,598	55,816,902	170,593,708
6 08	7,295,758	90.3	148,747,226	784,603	9.7	29,917,245	0	0.0	9,598	8,080,361	178,674,069
6 09	913,830	89.4	149,661,056	108,465	10.6	30,025,710	0	0.0	9,598	1,022,295	179,696,364
6 10	2,695,151	87.5	152,356,207	386,430	12.5	30,412,140	0	0.0	9,598	3,081,581	182,777,945
6 11	19,994,282	91.9	172,350,489	1,769,386	8.1	32,181,526	0	0.0	9,598	21,763,668	204,541,613
6 12	8,180,733	90.9	180,531,222	822,935	9.1	33,004,461	0	0.0	9,598	9,003,668	213,545,281
6 13	2,188,456	90.3	182,719,678	234,278	9.7	33,238,739	0	0.0	9,598	2,422,734	215,968,015
182,719,678			84.6	33,238,739			15.4	9,598			0.0
										215,968,015	

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 23. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolt, Ugashik River, 1988.

Date <sup>a</sup>	Mean Weight of Smolt (g)	Smolt per Count
5 17	7.1	5.9
5 18	7.9	5.2
5 19	7.9	5.2
5 20	7.9	5.2
5 21	7.9	5.2
5 22	7.9	5.2
5 23	7.9	5.3
5 24	6.5	6.4
5 25	6.3	6.6
5 26	7.6	5.4
5 27	8.5	4.9
5 28	8.3	5.0
5 29	7.0	6.0
5 30	7.6	5.4
5 31	8.8	4.7
6 01	7.2	5.8
6 02	6.8	6.1
6 03	7.7	5.4
6 04	6.9	6.0
6 05	6.7	6.2
6 06	6.3	6.6
6 07	6.3	6.6
6 08	6.1	6.8
6 09	6.1	6.8
6 10	6.5	6.4
6 11	5.8	7.1
6 12	5.8	7.1
6 13	5.9	7.1
6 14	5.7	7.2

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 24. Sockeye salmon spawning escapement, total number of smolt produced by age class, percent of total smolt production comprised by each age class, and number of smolt produced per spawner for 1979-1986 brood years, Ugashik River.

Brood Year	Total Spawning Escapement	Number of Smolt Produced					Per Spawner
		Age I	(%) <sup>a</sup>	Age II	(%) <sup>a</sup>	Age III	Total
1979	1,700,904	-	-	-	-	0	-
1980	3,321,384	-	-	12,736,379	-	26,384	-
1981	1,326,762	31,297,432	(27)	82,656,993	(73)	0	113,954,425 85.89
1982	1,157,526	75,491,249	(78)	21,407,762	(22)	0	96,899,011 83.71
1983	1,000,614	12,693,628	(46)	15,186,101	(54)	1,677	27,881,406 27.86
1984	1,241,418	37,890,152	(64)	21,483,727	(36)	9,598	59,383,477 47.84
1985	998,232	5,461,821	(14)	33,238,739	(86)	-	38,700,560 38.77 <sup>b</sup>
1986	1,001,493	182,719,678	-	-	-	-	-

<sup>a</sup> Percent of total smolt production

<sup>b</sup> Preliminary, age-III outmigration in 1989 may increase this total.

Table 25. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt) for 1979-1986 brood years, Ugashik River.

Brood Year	Total Spawning Escapement	Age I			Age II			Age III		
		Number of Smolt	Adult <sup>a</sup> Returns	Adult Returns per Smolt	Number of Smolt	Adult <sup>a</sup> Returns	Adult Returns per Smolt	Number of Smolt	Adult <sup>a</sup> Returns	Adult Returns per Smolt
1979	1,700,904	-	3,963,182		-	2,004,153		0	0	
1980	3,321,384	-	3,463,594		12,736,379	4,193,843	0.33	26,384	2,627	0.10
1981	1,326,762	31,297,432	4,171,203	0.13	82,656,993	3,173,571	0.04	0	1,679	0.00
1982	1,157,526	75,491,249	1,132,268	0.02	21,407,762	1,338,487	0.06 <sup>b</sup>	0	0	0.00 <sup>b</sup>
1983	1,000,614	12,693,628	987,416	0.08	15,186,101	951,463	0.06 <sup>b</sup>	1,677	1,048	0.62 <sup>b</sup>
1984	1,241,418	37,890,152	1,038,138	0.03 <sup>b</sup>	21,483,727	3,689,311	0.17 <sup>b</sup>	9,598	0	0.00 <sup>b</sup>
1985	998,232	5,461,821	520,004	0.10 <sup>b</sup>	33,238,739	1,757	0.00 <sup>b</sup>			
1986	1,001,493	182,719,678	496	0.00 <sup>b</sup>						

<sup>a</sup> Includes estimates of returns through 1988.

<sup>b</sup> Future adult returns may increase these values.

Table 26. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Ugashik River, 1988.

Date <sup>a</sup>	Age I					Age II				
	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size
5 16	89		5.0		1	116		11.7		1
5 17	86	8.5	5.2	1.99	63	110	16.7	10.5	4.94	43
5 18	85	7.6	5.3	1.68	27	110	10.1	12.0	9.01	11
5 19	83	15.2	4.9	3.03	45	111	16.0	11.0	4.44	15
5 21	87	3.6	5.4	0.65	2	110	6.5	10.5	1.90	2
5 22	86	14.3	5.8	1.94	59	110	20.9	11.2	5.36	38
5 23	88	13.3	5.9	2.26	54	109	13.5	10.5	4.17	46
5 24	86	10.8	5.6	2.65	86	105	17.6	9.9	5.85	13
5 25	88	11.5	5.7	2.67	78	108	23.4	10.9	7.12	22
5 26	87	8.0	5.6	1.76	66	109	21.5	10.9	7.32	34
5 27	88	9.1	5.7	1.86	44	118	17.1	14.2	7.09	56
5 28	88	9.1	6.1	2.53	72	107	21.4	10.2	5.57	28
5 29	89	11.0	5.8	2.04	84	108	13.3	9.9	4.15	15
5 30	90	12.8	6.2	3.23	57	111	17.0	10.8	4.57	40
5 31	91	12.2	6.9	3.58	52	109	26.2	11.4	12.99	46
6 01	89	10.6	6.1	2.63	66	111	14.8	11.3	4.65	31
6 02	90	10.6	6.3	2.69	87	106	21.0	10.1	5.36	11
6 03	89	7.6	5.9	2.05	71	114	23.3	12.8	7.35	29
6 04	87	10.5	6.1	3.01	96	106	8.0	11.2	2.25	4
6 05	88	13.4	5.9	3.13	79	105	15.3	9.5	4.29	14
6 06	89	12.4	6.1	2.43	99					0
6 07	88	7.8	5.7	1.81	97	99	5.9	7.5	1.19	2
6 08	87	11.0	5.4	2.41	96	103	4.8	9.1	1.39	4
6 09	87	12.8	5.9	2.75	86	109	16.0	11.0	4.99	11
6 10	88	17.4	5.9	3.31	94	113	8.7	12.3	1.33	3
6 11	85	9.6	5.2	2.28	101					0
6 12	85	12.9	5.5	2.55	100					0
6 13	85	16.3	5.4	3.21	99	108		10.5		1
6 14	83	10.3	4.9	2.03	98	118		10.3		1
Totals					2,059					521
Means	87		5.7			109		10.8		

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 27. Mean fork length and weight of sockeye salmon smolt sampled from the Ugashik River, 1958-1988.

Year of Migration	Sample Dates	Sample Size	Age I		Age II		Age III		References
			Mean Length	Mean Weight	Mean Length	Mean Weight	Mean Length	Mean Weight	
1958	-	-	93	6.4	112	11.7	-	-	Pella and Jaenicke (1978)
1959	-	-	90	6.1	120	13.5	-	-	"
1960	-	-	90	6.6	104	11.0	-	-	"
1961	-	-	90	6.7	112	12.2	-	-	"
1962	May 12 - Jun 28	1,070	88	6.1	112	12.3	-	-	Jaenicke (1963)
1963	May 05 - Jun 26	921	90	6.1	104	9.6	-	-	Nelson and Jaenicke (1965)
1964	May 15 - Jun 20	4,042	92	6.9	118	12.7	-	-	Nelson (1965a)
1965	May 13 - Jun 20	3,296	94	6.9	114	12.5	-	-	Nelson (1966a)
1967	May 15 - Jun 12	966	88	6.0	113	12.2	-	-	Nelson (1969)
1968	May 13 - Jun 24	6,727	93	6.5	113	10.7	-	-	Siedelman (1969)
1969	May 23 - Jun 06	567	97	7.5	121	14.5	-	-	Schroeder (1972a)
1970	May 15 - Jun 10	907	97	7.7	125	15.9	-	-	Schroeder (1972b)
1972	May 28 - Jun 20	615	81	5.0	112	11.2	129	14.3	Schroeder (1974a)
1973	May 17 - Jun 12	1,189	93	7.2	113	11.9	132	20.1	Schroeder (1974b)
1974	May 17 - Jun 17	355	94	7.4	119	13.6	-	-	Schroeder (1975)
1975	Jun 03 - Jun 13	-	96	7.2	116	13.0	125	16.7	Sanders (1976)
1982	Jun 06 - June 8	512	88	6.3	113	13.0	138	22.5	Eggers (1984)
1983	May 21 - Jun 16	9,502	89	7.6	111	13.2	-	-	Fried et al. (1987)
1984	May 23 - Jun 16	4,810	87	6.8	102	10.3	103	11.7	Fried et al. (1986)
1985	May 22 - Jun 17	3,473	94	8.3	107	11.8	-	-	Bue (1986)
1986	May 21 - Jun 14	1,555	87	5.8	114	10.9	-	-	Bue et al. (1988)
1987	May 18 - Jun 12	2,190	94	7.9	107	11.1	138	24.1	Cross et al (1990)
Mean			91	6.8	113	12.2	128	18.2	
1988	May 17 - Jun 14	2,581	87	5.7	109	10.8	128	15.6	

Table 28. Mean fork length and estimated weight, by estimated age of sockeye salmon smolt length frequencies, Ugashik River, 1988.

Date <sup>a</sup>	Estimated Age I				Estimated Age II			
	Mean Length (mm)	Std. Error	Estimated Mean Weight (g)	Sample Size	Mean Length (mm)	Std. Error	Estimated Mean Weight (g)	Sample Size
5 17 <sup>b</sup>	86	14.5	5.4	340	111	22.6	11.2	186
5 19	84	13.7	5.1	98	112	14.3	11.7	89
5 22	86	15.3	5.5	412	112	29.0	11.7	301
5 23	87	13.7	5.7	363	109	25.5	10.7	241
5 24	87	14.9	5.6	574	107	17.2	10.2	81
5 25	85	19.8	5.4	597	110	21.4	10.9	73
5 26	87	16.0	5.6	455	112	28.0	11.7	208
5 27	86	18.2	5.5	414	118	24.4	13.7	210
5 28	89	15.4	6.0	347	112	27.2	11.6	286
5 29	88	15.1	5.9	470	107	19.3	10.2	128
5 30	88	15.8	5.8	456	112	22.9	11.5	176
5 31	90	12.8	6.1	318	113	30.1	11.9	281
6 01	88	14.6	5.9	523	108	21.4	10.6	132
6 02	88	13.8	5.9	500	109	19.0	10.8	72
6 03	89	13.1	6.0	411	111	25.3	11.3	99
6 04	89	14.8	6.0	515	108	20.3	10.5	89
6 05	89	16.4	6.0	641	106	18.6	9.8	88
6 06	88	15.2	5.9	580	106	13.5	9.9	10
6 07	88	14.6	5.9	596	104	8.5	9.4	9
6 08	87	17.0	5.7	653	106	15.0	9.9	19
6 09	86	22.3	5.4	635	113	10.0	11.8	16
6 10	88	17.1	5.8	527	112	19.0	11.7	16
6 11	85	23.4	5.3	619	115	12.2	12.7	8
6 12	84	18.3	5.2	575	109	11.7	10.7	15
6 13	84	21.2	5.2	565	115	17.6	12.5	20
6 14	83	18.1	5.0	408	109	13.0	10.7	6
Totals				12,592				2,859
Means	87		5.6		110		11.1	

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

<sup>b</sup> Length-weight parameters by age group and discriminating length used to separate ages for May 16 through June 14 were:  
age I       $a = -10.79$        $b = 2.80$        $r^2 = 0.70$        $n = 2059$   
age II       $a = -11.66$        $b = 2.99$        $r^2 = 0.87$        $n = 521$   
discriminating length = 97.19

Table 29. Climatological and hydrological observations made at sockeye salmon smolt counting site, Ugashik River, 1988.

Date	Cloud Cover <sup>a</sup>		Wind Velocity (km/hr)		Air Temp. (°C)		Water Temp. (°C)		Water Clarity
	0800 hours	2000 hours	0800 hours	2000 hours	Min.	Max.	0800 hours	2000 hours	
5 15	3	2	5 SE	25 SE	-	-	-	3.5	clear
5 16	1	1	10 SE	10 SE	-	-	-	5.5	clear
5 17	4	1	10 SE	7 SE	-	-	-	7.0	clear
5 18	3	-	-	-	0.0	9.0	5.0	-	clear
5 19	3	4	5 SW	8 W	3.0	13.0	4.0	5.0	clear
5 20	4	3	8 W	8 W	4.0	15.0	4.5	4.5	clear
5 21	4	1	2 SE	15 NW	3.0	11.0	4.0	-	clear
5 22	1	1	-	calm	1.0	13.0	4.0	6.0	clear
5 23	2	3	5 W	calm	4.0	19.0	5.0	6.5	clear
5 24	1	2	5 SE	15 SE	7.0	14.0	7.0	8.5	clear
5 25	2	4	15 SE	25 SE	4.0	10.5	7.5	-	clear
5 26	4	2	20 SE	5 SE	5.0	10.0	6.0	6.5	clear
5 27	2	2	10 SW	25 WSW	8.0	-	5.5	6.0	clear
5 28	3	3	15 SW	10 E	3.0	14.0	5.5	6.5	clear
5 29	4	4	-	0-5 E	3.5	11.0	7.0	7.0	clear
5 30	3	4	-	15 W	5.0	10.0	6.0	5.5	clear
5 31	4	4	15 SW	0-5 W	2.0	13.0	5.0	5.0	clear
6 01	4	3	-	3 NE	2.5	9.5	5.0	6.0	clear
6 02	5	1	5 SW	15 NW	4.0	13.0	5.5	6.0	clear
6 03	4	1	15 W	15 W	3.0	16.0	5.0	6.0	clear
6 04	2	3	5 E	30 SE	2.0	15.0	5.5	7.0	clear
6 05	3	4	25 SE	15 SE	7.0	12.0	7.0	8.0	murky
6 06	4	4	5 SW	15 NW	5.0	12.5	7.0	7.0	lt. brown
6 07	4	3	5 SE	10 SE	5.0	14.0	6.0	8.5	clear
6 08	2	4	5 NE	35 SE	5.0	13.0	8.0	8.5	clear
6 09	4	4	25 SW	35 SE	4.5	13.0	8.0	8.0	clear
6 10	4	5	15 SE	calm	7.0	10.0	7.5	7.5	murky
6 11	5	4	-	calm	6.0	12.0	8.0	7.0	clear
6 12	1	1	2 SE	5 SE	6.5	15.0	7.5	9.5	clear
6 13	3	3	15 SE	20 SE	8.0	21.0	10.0	10.0	clear
6 14	3	3	35 SE	45 SE	7.0	12.5	9.5	9.0	clear
6 15	4	-	30 SE	-	7.0	8.0	-	8.0	murky

- <sup>a</sup> 1 = cloud cover not more than 1/10  
 2 = cloud cover not more than 1/2  
 3 = cloud cover more than 1/2  
 4 = completely overcast  
 5 = fog



Table 30. Water temperatures at sockeye salmon smolt counting site, Ugashik River, 1983-1988.

Year	Sample Period	Water Temperature (°C)			Reference
		Minimum	Maximum	Mean	
1983	May 23 - Jun 11	6.0	8.5	7.3	Fried et al. (1987)
1984	May 20 - Jun 17	4.8	8.5	6.3	Fried et al. (1986)
1985	May 17 - Jun 09	-1.0	7.0	4.3	Bue (1986)
1986	May 23 - Jun 28	2.0	7.0	5.6	Bue et al. (1988)
1987	May 17 - Jun 13	4.0	9.0	5.9	Cross et al. (1990)
Mean		3.2	7.9	5.9	
1988	May 17 - Jun 13	3.5	10.0	6.6	

Table 31. Sonar counts recorded from four arrays each with 10 transducers at the sockeye salmon smolt counting site on the Wood River, 1988.

	Sonar Counts				
	Transducer Array				
Date <sup>a</sup>	I	II	III	IV	Total
6 04 <sup>b</sup>	12,453	40,719	14,342	6,941	74,455
6 05	5,312	7,045	4,990	4,793	22,140
6 06	4,672	17,081	8,813	2,798	33,355
6 07	3,392	4,753	3,679	1,934	13,758
6 08	2,798	12,188	4,868	3,522	23,376
6 09	801	1,707	1,198	919	4,625
6 10	1,495	2,011	1,648	1,904	7,058
6 11	1,946	5,168	5,696	2,260	15,070
6 12	4,537	7,156	7,491	7,805	26,989
6 13	2,437	8,957	7,072	4,233	22,699
6 14	2,062	2,778	3,123	2,727	10,690
6 15	1,118	2,229	1,311	1,073	5,731
6 16	2,290	6,410	3,539	2,705	14,944
6 17	9,033	16,225	13,358	7,503	46,119
6 18	6,256	8,434	7,038	4,137	25,865
6 19	3,291	2,491	3,052	1,322	10,156
6 20	468	1,165	1,428	809	3,870
6 21	1,227	2,067	1,504	2,020	6,818
6 22	1,509	1,482	1,489	4,314	8,794
6 23	1,553	3,352	2,794	1,336	9,035
6 24	2,076	3,553	2,421	1,576	9,626
6 25	6,540	9,785	9,014	2,692	28,031
6 26	5,856	8,094	3,180	1,933	19,063
6 27	2,082	2,468	781	1,003	6,334
6 28	3,028	2,576	1,253	1,639	8,496
6 29	1,557	2,664	2,171	1,811	8,203
6 30	1,054	2,778	1,792	950	6,574
7 01	1,589	2,479	1,543	914	6,525
7 02	1,066	2,949	3,684	930	8,629
7 03	4,215	10,061	6,200	2,705	23,181
7 04	3,432	9,449	9,314	4,814	27,009
7 05	2,282	7,137	6,062	6,328	21,809

-Continued-

Table 31. (p 2 of 2).

	Sonar Counts				
	Transducer Array				
Date <sup>a</sup>	I	II	III	IV	Total
7 06 <sup>b</sup>	3,621	8,251	9,263	7,971	29,106
7 07	6,833	19,832	5,648	3,514	35,827
7 08	3,636	13,565	10,958	5,968	34,127
7 09	5,350	7,972	4,841	6,593	24,756
7 10	3,945	7,089	3,290	4,710	19,034
7 11	2,549	4,891	2,471	3,154	13,065
7 12	3,053	2,535	4,749	4,799	15,136
7 13	5,020	3,508	2,916	3,339	14,783
7 14	1,951	5,285	2,413	2,360	12,009
7 15	1,840	2,685	2,446	2,190	9,161
7 16	2,519	5,909	4,107	5,715	18,250
7 17	3,711	8,290	6,701	2,714	21,416
7 18	2,712	7,922	4,276	5,327	20,237
7 19	5,040	7,154	13,623	12,917	38,734
7 20	2,552	3,789	6,595	3,864	16,800
7 21	1,970	2,617	3,126	7,632	15,345
7 22	1,661	3,274	5,282	8,850	19,067
7 23	1,258	4,509	3,209	3,670	12,646
7 24	3,246	4,162	4,915	4,691	17,014
7 25	4,756	8,199	7,515	6,149	26,619
7 26	7,342	7,124	4,384	2,655	21,505
7 27	3,131	3,996	5,790	6,000	18,917
7 28	3,194	3,302	4,156	2,433	13,085
7 29	2,525	6,144	7,284	3,272	19,225
7 30	4,763	4,871	5,246	4,401	19,281
7 31	2,707	3,736	3,609	3,552	13,604
8 01	2,297	4,278	3,920	2,543	13,038
Total	196,609	382,300	288,581	223,324	1,090,814
Percent	18.0	35.1	26.5	20.5	

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

<sup>b</sup> Interpolated data for hours 0600-1100 on June 5, 1200-1700 and 1000-1100 on June 6, 1200-1700 on June 7, and each day from 1400-1600.

Table 32. Percentage of total unexpanded sonar counts recorded over each array, Wood River, 1975-1988.

Percentage of Sonar Counts					
Year	Transducer Array				References
	I	II	III	IV	
1975 <sup>a</sup>	68.6	31.4	-	-	Krasnowski (1976)
1976	49.0	30.2	11.7	9.1	Krasnowski (1977)
1977	36.0	24.4	20.8	18.8	Newcome (1978)
1978	28.6	29.7	25.6	16.1	Clark and Robertson (1980)
1979	17.0	27.1	33.1	22.8	Bucher (1980)
1980	34.1	35.2	20.5	10.2	Bucher (1981)
1981	39.2	24.8	24.9	11.1	Bucher (1982)
1982	38.2	31.3	15.9	14.6	Bucher (1984)
1983	31.6	29.9	23.5	15.0	Bucher (1987)
1984	23.9	36.7	22.2	17.2	Bucher (1986)
1985	34.2	36.3	18.5	11.0	Bucher (1986)
1986	34.2	36.3	18.5	11.0	Bue et al. (1988)
1987	30.9	32.3	20.8	16.0	Cross et al. (1990)
Mean <sup>b</sup>	33.1	31.2	21.3	14.4	
1988	18.0	35.1	26.5	20.5	

<sup>a</sup> Only two transducer arrays used.

<sup>b</sup> Data for 1975 omitted.

Table 33. Velocity correction factors used at Wood River, 1988.

Date	Array I	Array II	Array III	Array IV
6 05	1.00	1.00	1.00	0.92
6 12	1.00	1.00	1.00	0.92
6 21	1.00	1.11	1.13	1.15
6 26	1.00	1.07	1.08	1.10
7 01	1.00	1.12	1.16	1.18
7 06	1.00	1.07	1.11	1.13
7 12	1.00	1.05	1.14	1.12
7 19	1.00	1.06	1.13	1.11
7 25	1.00	1.10	1.12	1.15
8 01	1.00	1.11	1.11	1.18

Table 34. Daily number of sockeye salmon smolt migrating seaward, estimated with hydroacoustic equipment, Wood River, 1988.

Date <sup>a</sup>	Age I			Age II			All Ages	
	Number	Percent	Cumulative Total	Number	Percent	Cumulative Total	Daily Total	Cumulative Total
6 04	2,964,419	97.4	2,964,419	78,195	2.6	78,195	3042,614	3,042,614
6 05	941,626	97.4	3,906,045	24,838	2.6	103,033	966,464	4,009,078
6 06	1,385,801	97.7	5,291,846	32,623	2.3	135,656	1,418,424	5,427,502
6 07	590,170	97.7	5,882,016	13,893	2.3	149,549	604,063	6,031,565
6 08	1,054,561	98.7	6,936,577	14,323	1.3	163,872	1,068,884	7,100,449
6 09	215,314	98.7	7,151,891	2,924	1.3	166,796	218,238	7,318,687
6 10	337,868	98.7	7,489,759	4,588	1.3	171,384	342,456	7,661,143
6 11	634,605	96.2	8,124,364	24,999	3.8	196,383	659,604	8,320,747
6 12	1,207,114	96.2	9,331,478	47,551	3.8	243,934	1,254,665	9,575,412
6 13	967,204	96.2	10,298,682	38,101	3.8	282,035	1,005,305	10,580,717
6 14	472,509	96.2	10,771,191	18,613	3.8	300,648	491,122	11,071,839
6 15	244,100	96.2	11,015,291	9,615	3.8	310,263	253,715	11,325,554
6 16	632,810	96.2	11,648,101	24,928	3.8	335,191	657,738	11,983,292
6 17	1,835,045	95.7	13,483,146	81,851	4.3	417,042	1,916,896	13,900,188
6 18	1,031,866	95.7	14,515,012	46,025	4.3	463,067	1,077,891	14,978,079
6 19	457,283	98.7	14,972,295	5,976	1.3	469,043	463,259	15,441,338
6 20	179,815	98.7	15,152,110	2,349	1.3	471,392	182,164	15,623,502
6 21	379,524	98.7	15,531,634	4,959	1.3	476,351	384,483	16,007,985
6 22	379,186	89.5	15,910,820	44,532	10.5	520,883	423,718	16,431,703
6 23	322,697	89.5	16,233,517	37,898	10.5	558,781	360,595	16,792,298
6 24	345,477	89.5	16,578,994	40,573	10.5	599,354	386,050	17,178,348
6 25	1,097,083	96.9	17,676,077	35,331	3.1	634,685	1,132,414	18,310,762
6 26	715,471	96.9	18,391,548	23,041	3.1	657,726	738,512	19,049,274
6 27	262,154	98.6	18,653,702	3,803	1.4	661,529	265,957	19,315,231
6 28	360,688	98.6	19,014,390	5,232	1.4	666,761	365,920	19,681,151
6 29	316,284	97.6	19,330,674	7,777	2.4	674,538	324,061	20,005,212
6 30	242,339	97.6	19,573,013	5,959	2.4	680,497	248,298	20,253,510
7 01	249,854	97.6	19,822,867	6,143	2.4	686,640	255,997	20,509,507
7 02	332,631	97.6	20,155,498	8,179	2.4	694,819	340,810	20,850,317
7 03	880,340	97.6	21,035,838	21,647	2.4	716,466	901,987	21,752,304
7 04	1,014,825	98.8	22,050,663	12,014	1.2	728,480	1,026,83	22,779,143
7 05	877,039	98.8	22,927,702	10,382	1.2	738,862	887,421	23,666,564
7 06	1,116,355	98.8	24,044,057	13,215	1.2	752,077	1,129,57	24,796,134
7 07	1,224,188	97.7	25,268,245	28,434	2.3	780,511	1,252,62	26,048,756
7 08	1,255,232	97.7	26,523,477	29,155	2.3	809,666	1,284,38	27,333,143
7 09	956,783	97.7	27,480,260	22,223	2.3	831,889	979,006	28,312,149
7 10	711,681	99.1	28,191,941	6,608	0.9	838,497	718,289	29,030,438
7 11	488,912	99.1	28,680,853	4,539	0.9	843,036	493,451	29,523,889
7 12	557,291	99.1	29,238,144	4,947	0.9	847,983	562,238	30,086,127
7 13	508,309	99.1	29,746,453	4,512	0.9	852,495	512,821	30,598,948
7 14	360,824	97.7	30,107,277	8,607	2.3	861,102	369,431	30,968,379
7 15	286,843	97.7	30,394,120	6,842	2.3	867,944	293,685	31,262,064
7 16	595,952	97.7	30,990,072	14,216	2.3	882,160	610,168	31,872,232
7 17	579,316	98.7	31,569,388	7,630	1.3	889,790	586,946	32,459,178
7 18	591,109	98.7	32,160,497	7,785	1.3	897,575	598,894	33,058,072
7 19	1,201,793	98.7	33,362,290	15,829	1.3	913,404	1,217,622	34,275,694
7 20	452,304	98.3	33,814,594	7,775	1.7	921,179	460,079	34,735,773
7 21	472,865	98.3	34,287,459	8,128	1.7	929,307	480,993	35,216,766
7 22	582,502	98.3	34,869,961	10,013	1.7	939,320	592,515	35,809,281
7 23	349,108	98.3	35,219,069	6,001	1.7	945,321	355,109	36,164,390
7 24	470,630	99.3	35,689,699	3,222	0.7	948,543	473,852	36,638,242

-Continued-

Table 34. (p 2 of 2).

Date <sup>a</sup>	Age I			Age II			All Ages	
	Number	Percent	Cumulative Total	Number	Percent	Cumulative Total	Daily Total	Cumulative Total
7 25	732,518	99.3	36,422,217	5,015	0.7	953,558	737,533	37,375,775
7 26	547,668	99.3	36,969,885	3,749	0.7	957,307	551,417	37,927,192
7 27	555,217	99.3	37,525,102	3,801	0.7	961,108	559,018	38,486,210
7 28	378,401	99.6	37,903,503	1,710	0.5	962,818	380,111	38,866,321
7 29	556,613	99.6	38,460,116	2,516	0.5	965,334	559,129	39,425,450
7 30	572,810	99.6	39,032,926	2,589	0.5	967,923	575,399	40,000,849
7 31	413,203	99.6	39,446,129	1,867	0.5	969,790	415,070	40,415,919
8 01	381,892	99.6	39,828,021	1,726	0.5	971,516	383,618	40,799,537
	39,828,021	97.6		971,516	2.4		40,799,537	

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 35. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolt, Wood River, 1988.

Date <sup>a</sup>	Mean Weight of Smolt (g)	Smolt per Count	Date <sup>a</sup>	Mean Weight of Smolt (g)	Smolt per Count
6 04	4.4	9.4	7 04	5.9	7.0
6 05	4.4	9.4	7 05	5.9	7.0
6 06	4.2	9.8	7 06	5.9	7.0
6 07	4.2	9.8	7 07	5.7	7.2
6 08	4.0	10.3	7 08	5.7	7.2
6 09	4.0	10.3	7 09	5.7	7.2
6 10	4.0	10.3	7 10	5.9	7.0
6 11	4.2	9.8	7 11	5.9	7.0
6 12	4.2	9.8	7 12	6.4	6.4
6 13	4.2	9.8	7 13	6.4	6.4
6 14	4.2	9.8	7 14	7.1	5.8
6 15	4.2	9.8	7 15	7.1	5.8
6 16	4.2	9.8	7 16	7.1	5.8
6 17	4.5	9.3	7 17	7.8	5.3
6 18	4.5	9.3	7 18	7.8	5.3
6 19	4.1	10.2	7 19	7.8	5.3
6 20	4.1	10.2	7 20	8.5	4.9
6 21	4.1	10.2	7 21	8.5	4.9
6 22	5.3	7.8	7 22	8.5	4.9
6 23	5.3	7.8	7 23	8.5	4.9
6 24	5.3	7.8	7 24	8.5	4.9
6 25	5.1	8.2	7 25	8.5	4.9
6 26	5.1	8.2	7 26	8.5	4.9
6 27	4.8	8.6	7 27	8.5	4.9
6 28	4.8	8.6	7 28	8.0	5.2
6 29	5.4	7.6	7 29	8.0	5.2
6 30	5.4	7.6	7 30	8.0	5.2
7 01	5.4	7.6	7 31	8.0	5.2
7 02	5.4	7.6	8 01	8.0	5.2
7 03	5.4	7.6			

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.



Table 36. Sockeye salmon spawning escapements, total number of smolt produced by age class, percent of total smolt production comprised by each age class, and number of smolt produced per spawner for 1972-1986 brood years, Wood River.

Brood Year	Total Spawning Escapement	Number of Smolt Produced				
		Age I (%) <sup>a</sup>	Age II (%) <sup>a</sup>	Age III	Total	Per Spawner
1972	430,602	-	5,900,000	0	-	-
1973	330,474	27,950,000 (85)	4,800,000 (15)	0	32,750,000	99.24
1974	1,708,836	101,400,000 (89)	12,550,000 (11)	0	113,950,000	66.64
1975	1,270,116	60,750,000 (88)	8,400,000 (12)	0	69,150,000	54.45
1976	817,008	46,600,000 (90)	5,127,868 (10)	0	51,727,868	63.31
1977	561,828	60,838,182 (97)	1,993,345 (3)	0	62,831,527	111.83
1978	2,267,238	46,302,587 (58)	33,196,940 (42)	0	79,499,527	35.06
1979	1,706,352	64,330,507 (92)	4,706,853 (8)	0	69,037,360	40.46
1980	2,969,040	32,354,984 (89)	4,133,901 (11)	0	36,488,885	12.29
1981	1,233,318	19,594,247 (93)	1,378,417 (7)	0	20,972,664	17.01
1982	976,470	22,332,474 (83)	4,692,859 (17)	0	27,025,333	27.68
1983	1,360,968	31,948,110 (98)	597,724 (2)	2,592	32,548,426	23.92
1984	1,002,792	27,466,684 (92)	2,335,723 (8)	0	29,802,407	29.72
1985	939,000	29,039,259 (97)	971,516 (3)		30,010,775	31.96 <sup>b</sup>
1986	818,652	39,828,021				

<sup>a</sup> Percent of total smolt production

<sup>b</sup> Preliminary, age-III outmigration in 1989 might increase total

Table 37. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt), for 1972-1986 brood years, Wood River.

Brood Year	Total Spawning Escapement	Age I			Age II		
		Number of Smolt	Adult <sup>a</sup> Returns	Adult Returns per Smolt	Number of Smolt	Adult <sup>a</sup> Returns	Adult Returns per Smolt
1972	430,602	-	1,430,065		5,900,000	59,353	0.01
1973	330,474	27,950,000	1,364,992	0.05	4,800,000	118,476	0.02
1974	1,708,836	101,400,000	4,661,537	0.05	12,550,000	496,546	0.04
1975	1,270,116	60,750,000	3,617,378	0.06	8,400,000	1,141,143	0.14
1976	817,008	46,600,000	4,895,420	0.11	5,127,868	867,507	0.17
1977	561,828	60,838,182	3,399,952	0.06	1,993,345	116,606	0.06
1978	2,267,238	46,302,587	2,546,030	0.05	33,196,940	742,252	0.02
1979	1,706,352	64,330,507	4,497,413	0.07	4,706,853	46,750	0.01
1980	2,969,040	32,354,984	1,585,416	0.05	4,133,901	187,961	0.05
1981	1,233,318	19,594,247	1,815,951	0.09	1,378,417	179,333	0.13
1982	976,470	22,332,474	1,471,659	0.07	4,692,859	149,409	0.03
1983	1,360,968	31,948,110	3,184,011	0.10	597,724	91,141	0.15
1984	1,002,792	27,466,684	1,950,800	0.07	2,335,723	31,943	0.01 <sup>b</sup>
1985	939,000	29,039,259	1,175,197	0.04 <sup>b</sup>	971,516	0	0.00 <sup>b</sup>
1986	818,652	39,828,021	1,691	0.00 <sup>b</sup>			

<sup>a</sup> Includes estimates of returns through 1989.

<sup>b</sup> Future adult returns may increase these values.

Table 38. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Wood River, 1988.

Date <sup>a</sup>	Age I					Age II				
	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size
6 03	78	12.5	4.3	2.26	109	98	0.0	7.9	0.89	2
6 05	79	13.6	4.4	3.00	116	107	7.6	9.4	1.21	4
6 06	78	13.9	4.2	2.49	116	98	11.2	8.2	2.61	4
6 07	77	11.5	3.9	1.89	112	94	10.7	6.8	1.66	2
6 08	76	13.0	3.8	2.05	119	100		8.3		1
6 09	78	7.7	3.6	1.51	35					0
6 10	79	13.0	4.2	2.41	107	100	5.4	8.0	1.42	3
6 11	78	15.6	4.0	2.98	39	101	7.7	8.2	1.66	2
6 12	76	13.8	4.0	2.61	113	95	16.2	7.6	3.57	7
6 16	76	10.8	4.0	1.68	74	107	7.1	9.4	2.62	2
6 17	76	14.4	4.0	2.52	120					0
6 18	80	19.9	4.6	3.98	105	101	10.4	8.6	2.68	13
6 19	77	14.1	4.0	2.59	118	96	3.6	7.6	0.71	2
6 20	76	9.0	3.5	1.68	10					0
6 21	79	13.8	4.3	2.58	117	92	14.9	6.2	2.38	2
6 22	80	19.8	4.7	3.42	118	100	3.6	8.4	0.59	2
6 23	83	6.6	5.5	1.45	10	100	1.5	9.2	0.70	4
6 24	84	16.1	5.1	3.15	99	101	11.4	8.6	3.52	11
6 25	85	17.4	5.7	4.06	111	97	10.3	8.4	2.17	8
6 26	83	16.2	4.9	3.44	119	104		9.0		1
6 27	82	14.8	5.0	2.93	118	89	7.1	6.7	1.78	2
6 28	82	15.4	5.1	2.94	119	95		7.4		1
6 29	83	15.9	5.1	3.30	101	95		6.9		1
6 30	81	15.1	4.8	3.66	48					0
7 01	88	15.4	6.4	3.17	34	103	1.8	10.4	0.54	2
7 02	83	8.9	5.4	2.15	11					0
7 03	86	22.4	6.1	4.93	108	104	6.0	10.2	1.64	7
7 04	84	13.3	5.6	3.25	118	93		6.0		1
7 05	91	15.5	7.0	3.69	11					0
7 06	88	16.5	6.6	3.68	96	99	8.9	9.2	1.78	2
7 07	87	17.7	6.0	3.64	117	94	14.1	7.7	3.54	3
7 09	89	16.4	6.9	4.00	117	91	4.9	7.0	1.34	3
7 10	87	16.5	6.2	3.86	120					0
7 11	91	18.8	7.3	4.37	103	91		5.5		1
7 12	90	15.7	7.2	3.84	119	85		6.3		1
7 13	93	16.9	7.8	4.30	106					0
7 14	93	15.2	7.8	4.27	117	102	7.2	10.1	1.81	3
7 16	96	17.6	9.0	4.95	109	107	3.9	12.3	0.84	3
7 17	97	13.4	9.5	4.32	76	119	10.1	16.6	3.33	2
7 18	94	17.8	8.8	4.98	119	124		18.6		1
7 19	94	17.0	8.3	4.97	119					0
7 20	96	17.7	9.1	4.85	48	105		11.0		1
7 21	98	17.0	9.8	5.23	100	119	5.9	16.0	1.90	3
7 23	98	12.5	10.5	2.89	58					0
7 24	101	12.5	11.1	4.26	91					0
7 25	99	16.5	9.4	4.78	35					0
7 26	103	10.6	9.2	5.39	33					0
7 27	100	15.8	8.7	7.49	62	105		13.1		1
7 28	98	11.5	10.5	3.11	19					0
7 29	101	15.9	10.3	6.04	99					0
7 31	96	10.9	6.8	3.32	34					0
Totals					4,432					108
Means	87		6.3			100		9.2		

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 39. Age composition of total migration, and mean fork length and weight by age class, for sockeye salmon smolt, Wood River, 1951-1988.

Year of Migration	Age I			Age II			Total Estimate	References
	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)		
1951 <sup>a</sup>	80.0	91	-	20.0	-	-	-	Univ. Washington (unpub.)
1952	99.0	87	-	1.0	-	-	-	"
1953	95.3	86	-	4.7	103	-	-	"
1954	95.8	87	-	4.2	107	-	-	"
1955	98.0	85	-	2.0	102	-	-	"
1956	78.4	82	-	21.6	95	-	-	"
1957	80.7	77	-	19.3	93	-	-	"
1958	65.0	82	-	35.0	102	-	-	"
1959	93.5	88	-	6.5	105	-	-	"
1960	99.4	88	-	0.6	114	-	-	"
1961	93.0	82	-	7.0	102	-	-	Church (1963)
1962	86.0	80	-	14.0	98	-	-	Church and Nelson (1963)
1963	84.3	83	-	15.7	102	-	-	Nelson (1964)
1964	98.8	84	-	1.2	104	-	-	Nelson (1965b)
1965	92.0	86	-	8.0	106	-	-	Nelson (1966b)
1966	94.3	77	-	5.7	101	-	-	Siedelman (1967)
1975 <sup>b</sup>	86.0	83	-	14.0	98	-	33,850,000	Krasnowski (1976)
1976	95.5	84	-	4.5	95	-	106,200,000	Krasnowski (1977)
1977	82.9	71	3.5	17.1	98	9.3	73,300,000	Newcome (1978)
1978	84.7	79	-	15.3	90	-	55,000,000	Clark and Robertson (1980)
1979	92.2	90	7.6	7.8	100	10.1	65,966,050	Bucher (1980)
1980	96.0	78	4.0	4.0	95	6.8	48,295,932	Bucher (1981)
1981	66.1	88	6.3	33.9	96	8.4	97,527,446	Bucher (1982)
1982	87.3	79	4.7	12.7	98	8.4	37,061,837	Bucher (1984)
1983	82.6	86	6.5	17.4	98	9.2	23,728,252	Bucher (1987)
1984	94.2	92	7.8	5.8	97	8.7	23,710,947	Bucher (1986)
1985	87.2	92	7.2	12.8	91	7.1	36,640,969	Bucher (1986)
1986	97.9	87	5.9	2.1	101	9.2	54,661,948	Bue et al. (1988)
1987	92.6	86	5.8	7.4	100	8.7	36,227,371	Cross et al. (1990)
	Mean	84	5.9		100	8.6		
1988	97.0	87	6.3	3.0	100	9.2	40,799,537	

<sup>a</sup> Fyke net catches used to index abundance of smolt, 1951-66.

<sup>b</sup> Hydroacoustic equipment used to estimate numbers of smolt, 1975-88.

Table 40. Infection of age-I and age-II Wood River sockeye salmon smolt by the cestode *Triaenophorus crassus*, 1988.

Age I					Age II				
Age I		Age II		Age I		Age II		Age I	
Date	Number Examined	Number Infected	Number Examined	Number Infected	Date	Number Examined	Number Infected	Number Examined	Number Infected
6 04	111	55	2	1	7 03	49	14	0	0
6 06	116	71	4	4	7 04	107	45	8	3
6 07	116	64	4	4	7 05	118	55	1	1
6 08	117	67	3	3	7 06	11	7	0	0
6 09	119	71	1	1	7 07	96	33	2	2
6 10	35	24	0	0	7 08	117	43	3	2
6 11	107	67	3	3	7 10	117	65	3	0
6 12	38	20	3	2	7 11	120	59	0	0
6 13	113	60	7	5	7 12	103	49	1	0
6 17	74	36	2	1	7 13	119	56	0	0
6 18	120	44	0	0	7 14	107	9	0	0
6 19	107	33	13	7	7 15	117	11	3	0
6 20	118	46	2	0	7 17	109	6	3	0
6 21	10	4	0	0	7 18	77	4	2	0
6 22	118	56	2	1	7 19	118	10	1	0
6 23	118	32	2	0	7 20	119	19	1	0
6 24	10	6	4	1	7 21	48	8	1	0
6 25	99	34	11	2	7 22	101	6	3	0
6 26	113	68	7	5	7 25	91	52	0	0
6 27	119	85	1	1	7 26	35	21	0	0
6 28	118	64	2	0	7 27	33	20	0	0
6 29	119	44	1	1	7 28	63	31	1	0
6 30	102	50	1	0	7 29	19	0	0	0
7 01	49	14	0	0	7 30	99	60	0	0
7 02	34	9	2	1	8 01	34	19	0	0
Total					4,449	1,815	110	51	

Table 41. Infection of Wood River sockeye salmon smolt by the cestode *Triaenophorus crassus*, 1978-1988.

Year	Percent Infected		References
	Age I	Age II	
1978	15.1	40.5	Clark and Robertson (1980)
1979	10.0	30.8	Bucher (1980)
1980	11.1	17.3	Bucher (1981)
1981	28.2	35.6	Bucher (1982)
1982	10.0	21.2	Bucher (1984)
1983	43.1	73.6	Bucher (1987)
1984	41.1	45.7	Bucher (1986)
1985	35.7	41.5	Bucher (1986)
1986	40.8	45.6	Bue et al. (1988)
1987	42.6	57.8	Cross et al. (1990)
Mean	27.8	40.9	
1988	40.8	46.4	

Table 42. Climatological and hydrological observations made at sockeye salmon smolt counting site, Wood River, 1988.

Date	Cloud Cover <sup>a</sup>		Wind Velocity (km/hr)		Air Temp. (°C)		Water Temp. (°C)		Precipitation (mm)	Water Clarity
	0800 hours	2000 hours	0800 hours	2000 hours	0800 hours	2000 hours	0800 hours	2000 hours		
6 03	1	1	calm	-	8.5	-	3.5	-	0.0	clear
6 04	5	3	calm	10 NE	2.0	15.0	4.0	6.0	0.0	clear
6 05	4	4	calm	calm	3.0	9.0	5.0	6.0	15.2	clear
6 06	4	4	calm	calm	4.0	8.0	4.9	5.0	4.4	clear
6 07	4	3	calm	calm	5.0	10.0	4.9	8.0	0.0	clear
6 08	4	4	calm	calm	25.0	12.0	5.0	4.4	0.0	clear
6 09	4	4	calm	calm	16.0	8.0	5.0	4.0	21.6	clear
6 10	4	4	calm	calm	17.0	13.0	5.0	4.0	5.1	clear
6 11	2	3	calm	calm	16.0	17.0	5.0	4.0	0.0	clear
6 12	2	2	calm	calm	10.0	18.0	5.0	4.5	0.0	clear
6 13	2	2	calm	calm	11.0	18.0	4.0	-	0.0	clear
6 14	4	2	5-10 NE	5-10 NE	10.0	16.0	4.0	5.0	0.0	clear
6 15	3	3	calm	calm	10.0	19.0	4.5	5.0	2.5	clear
6 16	3	3	5-10 SE	calm	8.0	15.0	4.0	6.0	0.0	clear
6 17	1	4	5 SE	calm	12.0	15.0	4.5	6.0	0.0	clear
6 18	1	2	calm	calm	11.0	21.5	6.0	8.5	0.0	clear
6 19	4	2	calm	calm	6.0	17.0	7.0	7.0	0.0	clear
6 20	4	4	calm	5 NE	10.0	12.5	5.0	5.0	0.0	clear
6 21	2	2	5-10 E	calm	10.0	19.0	5.0	8.0	0.0	clear
6 22	1	2	10-15 SE	calm	10.5	23.0	7.5	9.5	0.0	clear
6 23	3	3	10-15 SE	10-15 NW	12.0	20.0	9.0	10.0	0.0	clear
6 24	4	2	8 NE	5-10 SE	13.0	20.0	8.5	9.0	0.0	clear
6 25	5	3	calm	calm	6.0	20.0	7.0	8.0	0.0	clear
6 26	5	-	calm	calm	10.0	16.0	8.0	8.0	0.0	clear
6 27	4	1	calm	5 SW	5.0	16.0	6.0	6.5	0.0	clear
6 28	4	4	calm	10 SW	6.0	12.0	5.5	6.5	2.5	clear
6 29	1	1	5 E	10 SW	6.0	21.0	6.0	7.0	0.0	clear
6 30	4	4	calm	5 SW	14.0	17.0	7.5	10.0	8.9	clear
7 01	5	5	calm	5-10 SW	11.0	20.0	9.5	10.0	0.0	clear
7 02	5	4	6 S	5 NE	11.0	10.0	9.5	8.5	0.0	clear
7 03	4	4	calm	calm	10.5	14.0	7.5	7.5	0.0	clear
7 04	4	4	5 SE	5 SE	10.0	15.0	7.0	9.0	0.0	clear
7 05	4	4	calm	calm	11.5	14.0	7.5	6.5	0.0	clear
7 06	4	4	3 NW	3 SW	10.0	12.0	7.5	7.5	22.9	clear
7 07	3	3	calm	2 SE	-	14.0	-	8.5	0.0	clear
7 08	5	4	calm	calm	9.5	19.0	8.5	9.0	0.0	clear
7 09	3	3	calm	2-5 SE	12.0	22.0	8.0	10.0	0.0	clear
7 10	4	4	calm	2-5 SW	14.5	17.0	11.0	13.0	0.0	clear
7 11	3	2	5-10 NW	calm	14.0	15.0	12.5	12.5	12.7	clear
7 12	3	3	calm	calm	13.0	19.0	12.5	13.0	0.0	clear
7 13	4	4	calm	calm	13.0	20.0	11.0	14.0	5.1	clear
7 14	4	1	calm	0-5 NE	14.0	22.0	14.0	14.5	7.6	clear
7 15	3	1	calm	5 SW	13.0	27.0	12.5	14.0	0.0	clear
7 16	2	1	calm	5	13.0	28.0	10.0	15.5	0.0	clear
7 17	5	1	0-5 NW	0-5 NW	12.0	28.0	10.0	10.0	0.0	clear
7 18	4	4	calm	calm	12.0	28.0	9.0	9.0	0.0	clear
7 19	3	1	5-10 SW	calm	12.0	24.0	8.0	11.0	0.0	clear
7 20	2	4	calm	calm	12.0	18.0	9.0	13.0	0.0	clear

-Continued-

Table 42. (p 2 of 2).

Date	Cloud Cover <sup>a</sup>		Wind Velocity (km/hr)		Air Temp. (°C)		Water Temp. (°C)		Precipitation (mm)	Water Clarity
	0800 hours	2000 hours	0800 hours	2000 hours	0800 hours	2000 hours	0800 hours	2000 hours		
7 21	5	3	5-10 NW	5-10 NW	13.0	18.0	12.0	13.0	0.0	clear
7 22	4	1	calm	5	13.0	21.0	10.0	11.0	0.0	clear
7 23	5	2	calm	calm	12.0	18.0	10.0	11.0	5.1	clear
7 24	5	3	calm	10-15 NE	12.0	17.0	11.0	12.0	0.0	clear
7 25	5	3	0-5 S	calm	12.0	15.0	12.0	13.0	0.0	clear
7 26	4	2	5 SE	5 NE	10.0	19.0	12.0	14.0	0.0	clear
7 27	4	4	calm	calm	11.0	14.0	13.0	12.0	8.9	clear
7 28	3	2	6 NE	calm	9.0	17.0	12.0	13.0	0.0	clear
7 29	4	3	calm	5-10 NW	12.0	20.0	13.0	14.0	0.0	clear
7 30	3	1	calm	5-10 NW	12.0	21.0	14.0	15.0	0.0	clear
7 31	4	4	calm	5-10 NW	12.0	13.0	14.0	13.5	0.0	clear
8 01	4	4	5-10 E	10-15 NE	12.0	13.0	12.0	11.0	0.0	clear

- <sup>a</sup>
- 1 = cloud cover not more than 1/10
  - 2 = cloud cover not more than 1/2
  - 3 = cloud cover more than 1/2
  - 4 = completely overcast
  - 5 = fog



Table 43. Water temperatures and depths at sockeye salmon smolt counting site, Wood River (outlet of Lake Aleknagik), 1988.

Date	Mean Water Temp. (°C)	Water Depth (m)	Date	Mean Water Temp. (°)	Water Depth (m)
6 03	3.5	1.10	7 03	7.5	1.27
6 04	5.0	1.24	7 04	8.0	1.21
6 05	5.5	1.49	7 05	7.0	1.18
6 06	5.0	1.49	7 06	7.5	1.16
6 07	6.5	1.44	7 07	8.5	1.16
6 08	4.7	1.47	7 08	9.0	1.10
6 09	4.5	1.48	7 09	9.0	1.09
6 10	4.5	1.56	7 10	12.0	1.06
6 11	4.5	1.59	7 11	12.5	1.04
6 12	5.0	1.62	7 12	13.0	1.03
6 13	4.0	1.61	7 13	12.5	0.99
6 14	4.5	1.66	7 14	14.5	0.99
6 15	5.0	1.68	7 15	13.5	0.97
6 16	5.0	1.70	7 16	13.0	0.97
6 17	5.5	1.68	7 17	10.0	0.94
6 18	7.5	1.68	7 18	9.0	0.94
6 19	7.0	1.61	7 19	9.5	0.81
6 20	5.0	1.59	7 20	11.0	0.79
6 21	6.5	1.59	7 21	12.5	0.73
6 22	8.5	1.58	7 22	10.5	0.72
6 23	9.5	1.55	7 23	10.5	-
6 24	9.0	1.55	7 24	11.5	0.60
6 25	7.5	1.48	7 25	12.5	0.60
6 26	8.0	1.65	7 26	13.0	0.57
6 27	6.5	1.40	7 27	12.5	0.58
6 28	6.0	1.38	7 28	12.5	-
6 29	6.5	1.34	7 29	13.5	0.55
6 30	9.0	1.36	7 30	14.5	0.50
7 01	10.0	1.32	7 31	14.0	0.49
7 02	9.0	1.27	8 01	12.5	0.51

Table 44. Water temperatures and depths at sockeye salmon smolt counting site, Wood River (outlet of Lake Aleknagik), 1975-1988.

Year	Sample Period	Water Temperature (°C)			Water Depth (m)			References
		Minimum	Maximum	Mean	Minimum	Maximum	Mean	
1975	May 29 - Jul 19	2.0	9.5	5.0	-0.24	0.57	0.37	Krasnowski (1976)
1976	Jun 09 - Aug 07	2.0	14.0	8.0	0.24	1.07	0.57	Krasnowski (1977)
1977	Jun 09 - Aug 08	4.5	15.5	9.0	-	-	1.52	Newcome (1978)
1978	May 28 - Aug 09	5.0	16.0	9.0	0.37	0.98	0.82	Clark and Robertson (1980)
1979	May 30 - Aug 02	4.5	16.0	9.0	0.33	1.46	0.93	Bucher (1980)
1980	May 30 - Aug 15	4.5	18.0	9.0	0.34	1.65	1.07	Bucher (1981)
1981	May 27 - Aug 13	5.4	17.5	11.4	0.03	1.21	0.55	Bucher (1982)
1982	May 27 - Aug 10	2.2	12.0	6.4	0.46	1.62	1.17	Bucher (1984)
1983	May 28 - Jul 26	4.4	12.8	8.7	0.46	1.19	0.90	Bucher (1987)
1984	May 22 - Jul 27	4.4	16.7	10.8	-0.21	0.23	0.01	Bucher (1986)
1985	Jun 06 - Aug 08	2.2	10.6	6.3	0.43	1.40	0.99	Bucher (1986)
1986	May 23 - Jul 17	3.0	10.5	6.1	-0.61	1.06	0.57	Bue et al. (1988)
1987	May 23 - Aug 05	4.0	16.0	6.8	0.49	1.96	1.27	Cross et al. (1989)
Mean		3.7	14.2	8.1	0.13	1.11	0.83	
1988	Jun 3 - Aug 01	3.5	15.5	8.8	0.49	1.70	1.20	

Table 45. Sonar counts recorded from three arrays each with 10 transducers at the sockeye salmon smolt counting site on the Nuyakuk River, 1988.

Date <sup>a</sup>	Transducer Array			Total
	Inshore	Center	Offshore	
5 27	0	0	0	0
5 28	0	0	0	0
5 29	0	0	0	0
5 30	202	580	100	882
5 31	594	831	303	1,728
6 01	262	746	251	1,259
6 02	407	1,118	694	2,219
6 03	342	940	818	2,100
6 04	209	1,239	510	1,958
6 05	138	486	618	1,242
6 06	1,857	3,132	1,545	6,534
6 07	3,480	5,323	4,934	13,737
6 08	2,213	2,319	2,071	6,603
6 09	721	1,636	1,858	4,215
6 10	1,478	2,124	2,445	6,047
6 11	8,938	16,951	24,966	50,855
6 12	2,228	4,867	3,575	10,670
6 13	531	964	800	2,295
6 14	1,445	1,994	986	4,425
6 15	1,421	2,295	1,623	5,339
6 16	1,253	2,502	1,570	5,325
6 17	1,060	1,758	1,669	4,487
6 18	675	1,219	786	2,680
6 19	711	1,093	670	2,474
6 20	237	339	230	806
6 21	858	1,693	1,124	3,675
6 22	672	914	444	2,030
6 23	150	176	127	453
6 24	160	177	201	538
6 25	357	544	620	1,521
6 26	45	151	169	365
Total	32,644	58,111	55,707	146,462
Percent	22.3	39.7	38.0	

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 46. Velocity correction factors used at Nuyakuk River, 1988.

Date	Inshore	Center	Offshore
5 27	1.00	1.00	0.97
6 02	1.00	1.02	1.04
6 04	1.00	0.97	1.02
6 09	1.00	0.97	0.97
6 16	1.00	1.07	1.03
6 21	1.00	0.98	1.04

Table 47. Daily number of sockeye salmon smolt, estimated with hydroacoustic equipment, Nuyakuk River, 1988.

Date <sup>a</sup>	Age I			Age II			All Ages	
	Number	Percent	Cumulative Total	Number	Percent	Cumulative Total	Daily Total	Cumulative Total
5 27	0	99.9	0	0	0.1	0	0	0
5 28	0	99.9	0	0	0.1	0	0	0
5 29	0	99.9	0	0	0.1	0	0	0
5 30	57,434	99.9	57,434	51	0.1	51	57,485	57,485
5 31	109,264	99.9	166,698	98	0.1	149	109,362	166,847
6 01	80,124	99.6	246,822	354	0.4	503	80,478	247,325
6 02	158,782	99.9	405,604	174	0.1	677	158,956	406,281
6 03	151,749	100.0	557,353	0	0.0	677	151,749	558,030
6 04	146,474	99.6	703,827	588	0.4	1,265	147,062	705,092
6 05	93,726	99.6	797,553	376	0.4	1,641	94,102	799,194
6 06	356,721	95.5	1,154,274	16,965	4.5	18,606	373,686	1,172,880
6 07	756,091	95.5	1,910,365	35,959	4.5	54,565	792,050	1,964,930
6 08	355,321	95.5	2,265,686	16,898	4.5	71,463	372,219	2,337,149
6 09	273,783	97.8	2,539,469	6,101	2.2	77,564	279,884	2,617,033
6 10	384,166	97.8	2,923,635	8,561	2.2	86,125	392,727	3,009,760
6 11	2,854,767	96.6	5,778,402	100,478	3.4	186,603	2,955,245	5,965,005
6 12	588,726	96.6	6,367,128	20,721	3.4	207,324	609,447	6,574,452
6 13	123,068	96.6	6,490,196	4,357	3.4	211,681	127,425	6,701,877
6 14	232,445	96.6	6,722,641	8,231	3.4	219,912	240,676	6,942,553
6 15	281,459	96.6	7,004,100	9,966	3.4	229,878	291,425	7,233,978
6 16	296,460	96.9	7,300,560	9,547	3.1	239,425	306,007	7,539,985
6 17	248,701	96.9	7,549,261	8,009	3.1	247,434	256,710	7,796,695
6 18	143,006	95.1	7,692,267	7,320	4.9	254,754	150,326	7,947,021
6 19	130,431	95.1	7,822,698	6,677	4.9	261,431	137,108	8,084,129
6 20	40,901	92.9	7,863,599	3,135	7.1	264,566	44,036	8,128,165
6 21	182,946	92.9	8,046,545	14,024	7.1	278,590	196,970	8,325,135
6 22	109,693	98.0	8,156,238	2,192	2.0	280,782	111,885	8,437,020
6 23	24,623	98.0	8,180,861	492	2.0	281,274	25,115	8,462,135
6 24	27,191	94.7	8,208,052	1,521	5.3	282,795	28,712	8,490,847
6 25	78,038	94.7	8,286,090	4,367	5.3	287,162	82,405	8,573,252
6 26	19,223	94.7	8,305,313	1,075	5.3	288,237	20,298	8,593,550
	8,305,313	96.7		288,237	3.3		8,593,550	

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 48. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolt, Nuyakuk River, 1988.

Date <sup>a</sup>	Mean Weight of Smolt (g)	Smolt per Count
5 27	3.4	12.2
5 28	3.4	12.2
5 29	3.4	12.2
5 30	3.4	12.2
5 31	3.4	12.2
6 01	3.5	12.0
6 02	3.2	13.0
6 03	3.2	13.1
6 04	2.9	14.1
6 05	2.9	14.1
6 06	3.7	11.3
6 07	3.7	11.3
6 08	3.7	11.3
6 09	3.2	13.1
6 10	3.2	13.1
6 11	3.6	11.7
6 12	3.6	11.7
6 13	3.6	11.4
6 14	3.6	11.4
6 15	3.6	11.4
6 16	3.7	11.3
6 17	3.7	11.3
6 18	3.8	11.1
6 19	3.8	11.1
6 20	3.8	10.9
6 21	3.8	10.9
6 22	3.6	11.5
6 23	3.6	11.5
6 24	3.8	10.9
6 25	3.8	10.9
6 26	3.8	10.9

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 49. Sockeye salmon spawning escapements, total number of smolt produced by age class, percent of total smolt production comprised by each age class, and number of smolt produced per spawner for 1980-1986 brood years, Nuyakuk River.

Brood Year	Total Spawning Escapement	Number of Smolt Produced				Per Spawner
		Age I	(%) <sup>a</sup>	Age II	(%) <sup>a</sup>	Total
1980	3,026,568	-		1,259,339		-
1981	834,204	28,875,158	(99)	89,911	( 1)	28,965,069
1982	537,864	6,293,644	(89)	769,319	(11)	7,062,963
1983	318,606	22,596,725	(99)	172,411	( 1)	22,769,136
1984	472,596	11,063,753	(96)	495,634	( 4)	11,559,387
1985	429,162	7,280,226	(96)	288,237	( 4)	7,568,463
1986	821,898	8,305,313				

<sup>a</sup> Percent of total smolt production

Table 50. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt) for 1979-1986 brood years, Nuyakuk River.

Brood Year	Total Spawning Escapement	Age I			Age II		
		Number of Smolt	Adult <sup>a</sup> Returns	Adult Returns per Smolt	Number of Smolt	Adult <sup>a</sup> Returns	Adult Returns per Smolt
1980	3,026,568	-	643,982		1,259,339	212,695	0.17
1981	834,204	28,875,158	2,022,007	0.07	89,911	26,895	0.30
1982	537,864	6,293,644	615,403	0.10	769,319	10,430	0.01
1983	318,606	22,596,725	678,145	0.03	172,411	2,419	0.01
1984	472,596	11,063,753	51,133	0.01	495,634	0	0.00 <sup>b</sup>
1985	429,162	7,280,226	0	0.00 <sup>b</sup>	288,237	0	0.00 <sup>b</sup>
1986	821,898	8,305,313	0	0.00 <sup>b</sup>			

<sup>a</sup> Includes estimates of returns through 1989.

<sup>b</sup> Future adult returns may increase these values.



Table 51. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Nuyakuk River, 1988.

Date <sup>a</sup>	Age I					Age II				
	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size
5 29	73	13.1	3.5	1.58	26					0
5 30	74	12.0	3.8	2.60	100					0
5 31	73	11.4	3.1	1.99	100					0
6 01	73	13.7	3.6	2.42	99	74		4.8		1
6 02	73	13.3	3.1	1.72	100					0
6 03	73	13.2	3.1	1.67	100					0
6 04	72	16.0	2.9	2.41	98	88		5.5		1
6 05	70	16.8	2.8	2.10	98					0
6 07	78	17.6	3.7	2.67	93	88	5.5	5.3	1.32	7
6 08	77	21.0	3.6	2.88	94	85	4.2	5.0	0.88	5
6 09	75	17.7	3.4	2.53	96	86	5.1	5.0	0.50	4
6 10	70	18.6	3.0	2.57	100					0
6 11	80	13.4	3.9	2.05	89	87	4.7	5.2	0.97	11
6 12	79	17.1	4.0	2.36	94	87	4.4	5.2	0.69	6
6 13	77	17.3	3.7	2.37	99	84		4.5		1
6 14	75	23.2	3.6	3.15	95	85		4.7		1
6 15	77	12.3	4.0	2.04	94	85	6.6	5.3	1.05	6
6 16	78	14.4	4.1	2.19	94	88	9.1	5.3	1.18	6
6 17	76	16.4	3.7	2.52	95	87	3.5	5.1	0.48	5
6 18	78	14.3	3.9	2.17	90	84	5.0	5.0	1.03	10
6 19	75	18.7	3.6	2.69	96	84	5.2	4.6	1.00	4
6 20	77	15.4	3.9	2.41	89	84	4.2	4.7	0.37	7
6 21	76	16.6	3.9	2.51	93	86	5.7	5.1	0.97	7
6 22	76	16.7	3.8	2.28	98	86	2.4	5.1	0.71	2
6 23	73	19.5	3.4	2.74	96	84	6.5	5.1	1.66	2
6 24	76	18.1	3.9	2.82	95	86	5.0	5.3	0.99	5
6 25	77	17.1	4.1	2.43	91	86	6.9	5.3	1.11	9
Totals					2,512					100
Means	75		3.6			85		5.1		

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 52. Mean fork length and weight by age class, for sockeye salmon smolt, Nuyakuk River, 1978, and 1982-1988.

Year of Migration	Sample Dates	Sample Size	Age I		Age II		References
			Mean Length (mm)	Mean Weight (g)	Mean Length (mm)	Mean Weight (g)	
1978	Jun 18 - Jun 19	350	71	4.3	85	5.8	Huttunen (1980)
1982	Jun 15 - Jul 09	208	76	3.9	96	6.8	Minard (1984)
1983	May 27 - Jun 30	1,847	75	4.3	91	6.6	Minard and Frederickson (1987)
1984	May 27 - Jun 26	980	81	4.9	93	7.3	Minard and Frederickson (1986)
1985	May 24 - Jun 28	1,479	85	5.5	89	6.6	Minard and Brandt (1986)
1986	May 24 - Jun 27	1,840	81	4.7	91	6.2	Bue et al. (1988)
1987	May 29 - Jun 27	1,597	78	4.1	91	6.2	Cross et al. (1990)
Mean			78	4.5	91	6.5	
1988	May 29 - Jun 27	2,612	75	3.6	85	5.1	

Table 53. Mean fork length and estimated weight, by estimated age of sockeye salmon smolt length frequencies, Nuyakuk River, 1988.

Date <sup>a</sup>	Estimated Age I				Estimated Age II			
	Mean Length (mm)	Std. Error	Estimated Weight (g)	Sample Size	Mean Length (mm)	Std. Error	Estimated Weight (g)	Sample Size
5 30 <sup>b</sup>	74	15.0	3.4	216	86		5.1	1
5 31	72	13.8	3.1	155				0
6 01	73	15.7	3.3	300	86		5.1	1
6 02	71	18.0	3.0	299	87		5.2	1
6 03	72	18.2	3.1	329				0
6 04	70	17.5	2.9	223	87	1.2	5.2	2
6 05	69	15.4	2.7	129				0
6 07	75	21.1	3.6	265	88	6.1	5.5	12
6 08	76	19.3	3.6	224	87	3.2	5.3	13
6 09	73	21.2	3.3	237	87	3.5	5.3	12
6 10	69	22.2	2.8	224	86	0.6	5.2	2
6 11	77	20.3	3.8	220	87	2.2	5.2	8
6 12	70	26.1	2.9	239	88	1.1	5.3	3
6 13	74	22.6	3.4	136	86	0.6	5.2	4
6 15	75	23.6	3.5	212	87	5.7	5.3	14
6 16	75	18.6	3.6	212	86	0.8	5.1	6
6 17	74	18.6	3.4	90	90	5.4	5.7	2
6 18	78	15.4	4.0	151	89	6.3	5.6	15
6 19	76	21.6	3.6	240	86	1.7	5.2	8
6 20	75	16.5	3.6	84	88	1.9	5.4	3
6 21	76	19.4	3.6	208	88	5.5	5.5	31
6 22	76	20.4	3.6	199	88	3.5	5.5	6
6 24	76	19.4	3.6	144	86	1.9	5.2	12
6 25	75	17.8	3.6	119	87	2.8	5.3	6
Totals				4,855				162
Means	74		3.4		87		5.3	

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

<sup>b</sup> Length-weight parameters by age group and discriminating length used to separate ages from May 29 through June 26 were:  
age I       $a = -11.43$      $b = 2.93$      $r^2 = 0.82$      $n = 2512$   
age II       $a = -8.52$      $b = 2.28$      $r^2 = 0.67$      $n = 100$   
discriminating length = 85.50

Table 54. Climatological and hydrological observations made at sockeye salmon smolt counting site, Nuyakuk River, 1988.

Date	Cloud Cover <sup>a</sup>		Wind Velocity (km/hr)		Air Temp. (°C)		Water Temp. (°C)		Precipitation (mm)	Water Clarity
	0800 hours	2000 hours	0800 hours	2000 hours	0800 hours	2000 hours	0800 hours	2000 hours		
5 25	1	3	10 E	-	4.5	6.5	-	3.0	trace	clear
5 26	4	2	calm	10 E	5.5	10.0	3.0	3.5	0.0	light brown
5 27	3	3	calm	calm	4.5	15.0	3.0	3.5	0.0	light brown
5 28	3	4	calm	calm	8.5	12.0	3.0	3.0	0.0	light brown
5 29	4	3	5 N	5 N	6.5	10.0	3.0	3.5	0.0	light brown
5 30	2	3	5 E	0-5 NE	4.5	13.0	2.7	3.5	0.0	light brown
5 31	3	4	5 NE	0-5 NE	6.5	8.5	2.0	4.0	0.0	light brown
6 01	4	1	calm	5 N	6.0	14.0	2.0	4.5	0.0	light brown
6 02	1	1	calm	5 NW	4.5	17.0	2.0	4.5	0.0	light brown
6 03	1	1	5 NW	10 NW	10.5	18.0	3.0	5.0	0.0	light brown
6 04	1	2	calm	5-10 S	11.0	15.0	4.0	4.5	0.0	light brown
6 05	4	4	5 E	0-5 S	7.0	11.0	4.0	4.0	0.0	light brown
6 06	4	2	calm	5-10 NE	7.0	8.0	4.0	4.0	0.0	light brown
6 07	2	3	0-5 N	0-5 N	6.5	10.0	4.0	4.0	0.0	light brown
6 08	3	4	calm	0-5 S	8.0	14.0	4.5	4.5	0.0	light brown
6 09	4	4	0-5 E	calm	8.5	9.0	4.5	4.0	0.0	light brown
6 10	4	4	calm	calm	6.0	7.0	4.5	4.5	12.7	light brown
6 11	3	3	calm	calm	5.5	11.5	4.0	4.5	trace	-
6 12	2	3	calm	5 NW	6.5	15.0	4.5	5.5	trace	light brown
6 13	3	-	0-5 SE	-	9.0	10.0	5.0	5.5	0.0	light brown
6 14	3	3	10-15 SE	15 SE	9.0	8.0	5.0	5.5	0.0	light brown
6 15	4	2	5 SE	15 SE	8.0	13.5	5.0	5.5	0.0	light brown
6 16	3	2	5 NE	5-10 NW	6.5	13.0	5.0	5.5	0.0	light brown
6 17	2	3	0-10 NW	5-10 NE	11.5	14.0	5.0	5.5	0.0	light brown
6 18	1	3	0-5 NE	0-5 NE	14.5	19.5	6.0	7.5	0.0	light brown
6 19	5	3	calm	0-5 NE	5.5	19.5	6.5	7.5	0.0	light brown
6 20	4	4	calm	calm	9.0	12.0	6.5	5.5	trace	light brown
6 21	4	3	calm	5 NE	8.0	16.0	6.0	7.5	0.0	light brown
6 22	1	3	5-10 NE	5-10 NW	6.5	17.0	7.5	9.0	0.0	light brown
6 23	4	3	calm	10 N	9.0	15.0	9.0	10.0	0.0	light brown
6 24	3	2	calm	0-5 E	11.0	19.5	9.0	9.5	0.0	light brown
6 25	3	3	5 N	calm	13.0	18.0	9.0	9.5	0.0	light brown
6 26	3	3	5 E	5 S	11.5	15.0	9.0	9.5	0.0	light brown
6 27	4	-	5 E	-	10.0	-	8.5	-	0.0	-

- <sup>a</sup> 1 = cloud cover not more than 1/10  
 2 = cloud cover not more than 1/2  
 3 = cloud cover more than 1/2  
 4 = completely overcast  
 5 = fog

Table 55. Sonar counts recorded from two arrays each with 10 transducers at the sockeye salmon smolt counting site on the Togiak River, 1988.

Date <sup>a</sup>	Transducer Array		Total
	Inshore	Offshore	
6 06	285	1,489	1,774
6 07	1,015	6,417	7,432
6 08	411	1,079	1,490
6 09	133	606	739
6 10	376	487	863
6 11	531	747	1,278
6 12	734	981	1,715
6 13	583	1,640	2,223
6 14	261	1,230	1,491
6 15	477	746	1,223
6 16	908	1,618	2,526
6 17	1,027	1,100	2,127
6 18	427	346	773
6 19	121	334	455
6 20	89	197	286
6 21	159	131	290
6 22	128	254	382
6 23	91	245	336
6 24	395	464	859
6 25	41	120	161
6 26	17	75	92
6 27	21	62	83
6 28	35	157	192
6 29	144	74	218
6 30	88	236	324
Total	8,497	20,835	29,332
Percent	29.0	71.0	

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 56. Velocity correction factors used  
at Togiak River, 1988.

Date	Array I	Array II
6 07	1.00	0.97
6 08	0.98	1.00
6 09	0.95	0.97
6 10	1.00	0.99
6 11	1.00	0.99
6 12	1.08	1.10
6 13	1.00	1.02
6 14	1.04	1.04
6 15	1.01	1.15
6 16	1.08	1.03
6 17	0.99	0.94
6 18	0.97	0.87
6 19	1.01	0.92
6 20	0.93	0.91
6 21	0.96	0.93
6 22	1.01	0.96
6 23	0.96	0.94
6 24	0.99	0.94
6 25	0.97	0.96
6 26	0.97	0.95
6 27	0.97	0.94
6 28	0.97	0.98
6 29	1.00	1.03
6 30	1.00	1.00
7 01	1.00	0.98

Table 57. Daily number of sockeye salmon smolt, estimated with hydroacoustic equipment, Togiak River, 1988.

Date <sup>a</sup>	Age I			Age II			All Ages	
	Number	Percent	Cumulative Total	Number	Percent	Cumulative Total	Daily Total	Cumulative Total
6 06	179,849	99.7	179,849	504	0.3	504	180,353	180,353
6 07	762,136	99.7	941,985	2,139	0.3	2,643	764,275	944,628
6 08	6,931	99.7	948,916	19	0.3	2,662	6,950	951,578
6 09	73,181	99.7	1,022,097	205	0.3	2,867	73,386	1,024,964
6 10	76,616	99.7	1,098,713	215	0.3	3,082	76,831	1,101,795
6 11	93,222	98.9	1,191,935	1,046	1.1	4,128	94,268	1,196,063
6 12	136,967	98.9	1,328,902	1,537	1.1	5,665	138,504	1,334,567
6 13	181,408	97.8	1,510,310	4,118	2.2	9,783	185,526	1,520,093
6 14	130,557	97.8	1,640,867	2,964	2.2	12,747	133,521	1,653,614
6 15	117,470	99.8	1,758,337	247	0.2	12,994	117,717	1,771,331
6 16	229,529	99.8	1,987,866	483	0.2	13,477	230,012	2,001,343
6 17	166,651	99.8	2,154,517	350	0.2	13,827	167,001	2,168,344
6 18	61,442	98.9	2,215,959	689	1.1	14,516	62,131	2,230,475
6 19	43,495	98.9	2,259,454	488	1.1	15,004	43,983	2,274,458
6 20	28,624	100.0	2,288,078	0	0.0	15,004	28,624	2,303,082
6 21	26,257	100.0	2,314,335	0	0.0	15,004	26,257	2,329,339
6 22	39,014	100.0	2,353,349	0	0.0	15,004	39,014	2,368,353
6 23	34,719	100.0	2,388,068	0	0.0	15,004	34,719	2,403,072
6 24	84,517	99.4	2,472,585	475	0.6	15,479	84,992	2,488,064
6 25	17,888	99.4	2,490,473	100	0.6	15,579	17,988	2,506,052
6 26	10,507	100.0	2,500,980	0	0.0	15,579	10,507	2,516,559
6 27	9,089	100.0	2,510,069	0	0.0	15,579	9,089	2,525,648
6 28	22,744	100.0	2,532,813	0	0.0	15,579	22,744	2,548,392
6 29	20,659	100.0	2,553,472	0	0.0	15,579	20,659	2,569,051
6 30	37,962	100.0	2,591,434	0	0.0	15,579	37,962	2,607,013
	2,591,434	99.4		15,579	0.6		2,607,013	

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 58. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolt, Togiak River, 1988.

Date <sup>a</sup>	Mean Weight of Smolt (g)	Smolt per Count
6 06	4.1	10.0
6 07	4.1	10.0
6 08	4.1	10.0
6 09	4.1	10.0
6 10	4.1	10.0
6 11	5.0	8.3
6 12	5.0	8.3
6 13	4.9	8.4
6 14	4.9	8.4
6 15	4.3	9.6
6 16	4.3	9.6
6 17	4.3	9.6
6 18	3.9	10.6
6 19	3.9	10.6
6 20	3.6	11.5
6 21	3.6	11.5
6 22	3.7	11.1
6 23	3.7	11.1
6 24	3.6	11.6
6 25	3.6	11.6
6 26	3.6	11.5
6 27	3.6	11.5
6 28	3.6	11.5
6 29	3.6	11.5
6 30	3.6	11.5

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.



Table 59. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Togiak River, 1988.

Date <sup>a</sup>	Age I					Age II				
	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size
6 08	75	18.6	4.5	3.38	59					0
6 09	73	2.8	4.5	1.64	5					0
6 10	74	18.2	3.5	3.13	119	91		7.1		1
6 11	79	26.3	6.1	6.04	87	90	6.6	8.7	0.67	3
6 12	76	20.2	4.3	3.35	120					0
6 13	84	39.3	6.0	7.90	114	104	5.5	10.8	2.08	6
6 14	75	26.0	4.0	4.67	118	103	1.8	10.3	0.42	2
6 15	72		4.0		1					0
6 16	79	22.7	4.9	4.28	120					0
6 17	75	25.4	4.0	4.32	119	83		5.7		1
6 18	73	19.2	3.7	3.10	118	92	2.4	7.1	0.89	2
6 19	70	17.0	3.4	2.84	118	87	4.2	6.9	0.48	2
6 20	70	13.3	3.2	2.29	52					0
6 21	69	16.0	3.2	2.55	120					0
6 22	71	16.1	3.5	2.80	120					0
6 23	70	14.5	3.3	2.40	120					0
6 24	70	15.8	3.2	2.38	119	90		5.2		1
6 25	69	13.1	3.1	2.07	119	78		4.5		1
6 26	70	9.9	3.7	2.11	15					0
6 27	71	10.3	3.0	1.38	15					0
6 29	74	11.5	3.3	2.27	6					0
Totals					1,784					19
Means	73		3.9			91		7.4		

<sup>a</sup> Sample day began at 1200 hours and ended at 1159 hours the next calendar day.

Table 60. Climatological and hydrological observations made at sockeye salmon smolt counting site, Togiak River, 1988.

Date	Cloud Cover <sup>a</sup>		Wind Velocity (km/hr)		Air Temp. (°C)		Water Temp. (°C)		Precipitation (mm)
	0800 hours	2000 hours	0800 hours	2000 hours	0800 hours	2000 hours	0800 hours	2000 hours	
6 03	1	1	0-5 N	0-5 N	-	-	3.5	-	0.0
6 04	3	3	5-10 N	5-10 N	10.0	-	-	4.0	0.0
6 05	4	4	10-15 N	-	8.5	9.0	-	4.0	0.0
6 06	3	4	5-10 S	-	7.0	9.0	4.0	-	0.0
6 07	4	3	-	-	7.0	-	-	-	0.0
6 08	3	4	10-15 N	10 NE	10.0	11.0	-	5.0	0.0
6 09	4	4	10-15 NE	5 NE	9.5	-	-	4.5	0.0
6 10	4	3	5 NE	-	10.0	11.0	-	4.5	0.0
6 11	5	1	-	-	7.0	16.5	-	-	0.0
6 12	4	2	2-3 NE	-	8.0	18.5	4.0	-	0.0
6 13	2	4	5-10 NE	5-10 NE	18.0	16.0	-	-	0.0
6 14	4	3	10-15 NE	5 NE	10.5	13.0	-	-	0.0
6 15	3	4	5-10 NE	5 NE	11.0	10.0	5.0	-	trace
6 16	3	1	2-3 NE	-	10.0	15.5	-	-	0.0
6 17	2	2	-	5 NW	6.5	22.0	-	-	0.0
6 18	1	2	-	5-10 SW	14.0	22.0	-	-	0.0
6 19	5	1	-	5 SW	8.0	21.0	-	-	0.0
6 20	2	4	-	-	6.5	13.0	5.0	-	trace
6 21	4	1	-	5-10 NW	8.0	23.0	5.0	-	0.0
6 22	1	1	-	5 NW	6.0	22.0	5.0	-	0.0
6 23	2	1	-	-	6.5	21.0	5.5	-	0.0
6 24	3	1	-	5 SW	5.0	21.5	5.5	-	0.0
6 25	1	3	-	5-10 SW	10.0	22.0	5.0	-	0.0
6 26	1	1	-	5-10 SW	9.5	21.0	5.0	-	0.0
6 27	5	1	-	-	8.0	20.5	5.0	-	0.0
6 28	1	4	-	-	4.5	16.5	5.5	-	0.0
6 29	1	1	-	-	9.5	24.5	5.5	-	0.0

- <sup>a</sup> 1 = cloud cover not more than 1/10  
 2 = cloud cover not more than 1/2  
 3 = cloud cover more than 1/2  
 4 = completely overcast  
 5 = fog

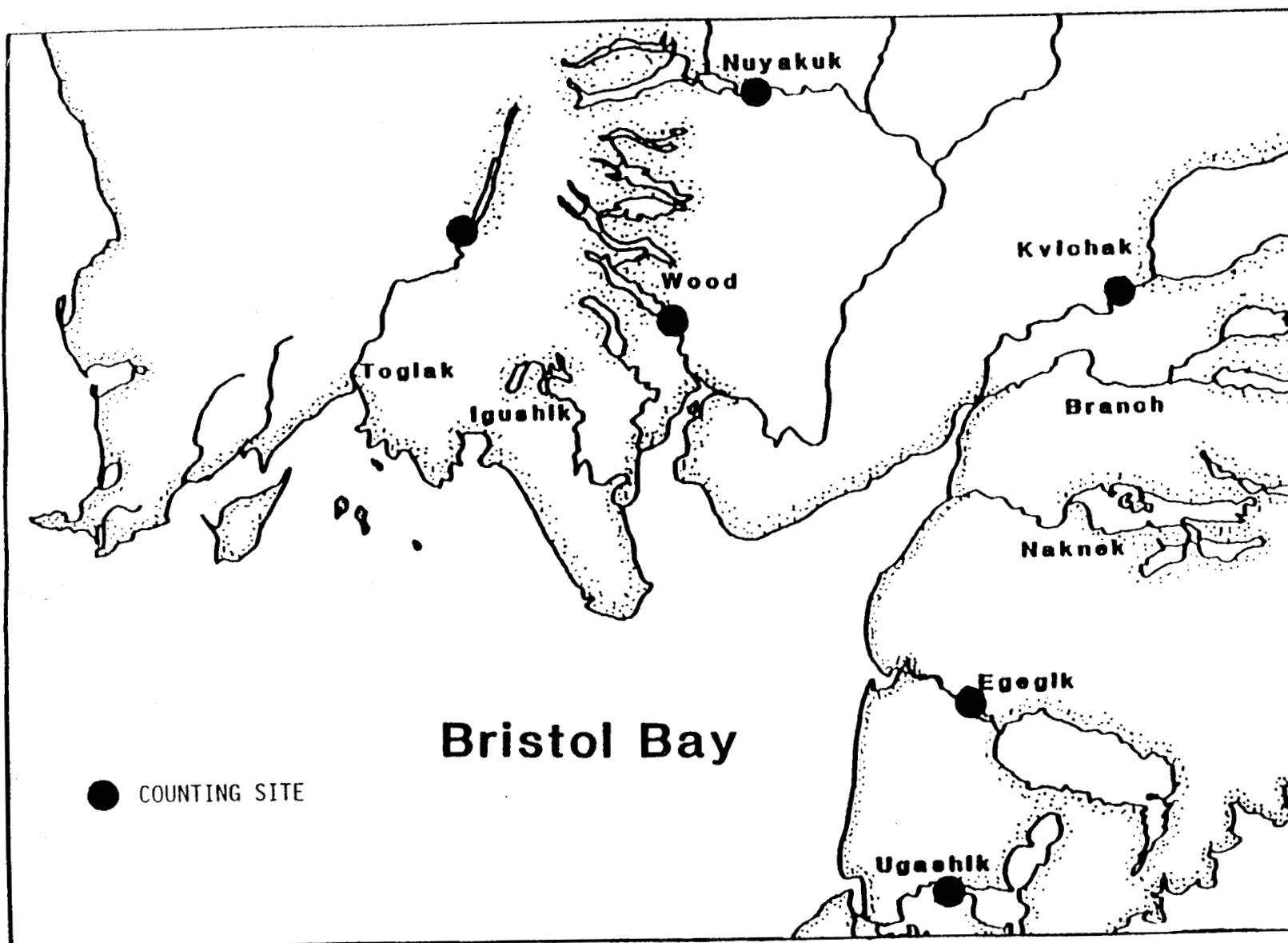


Figure 1. Bristol Bay management area with major rivers and smolt project locations

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